Electronic Engineering

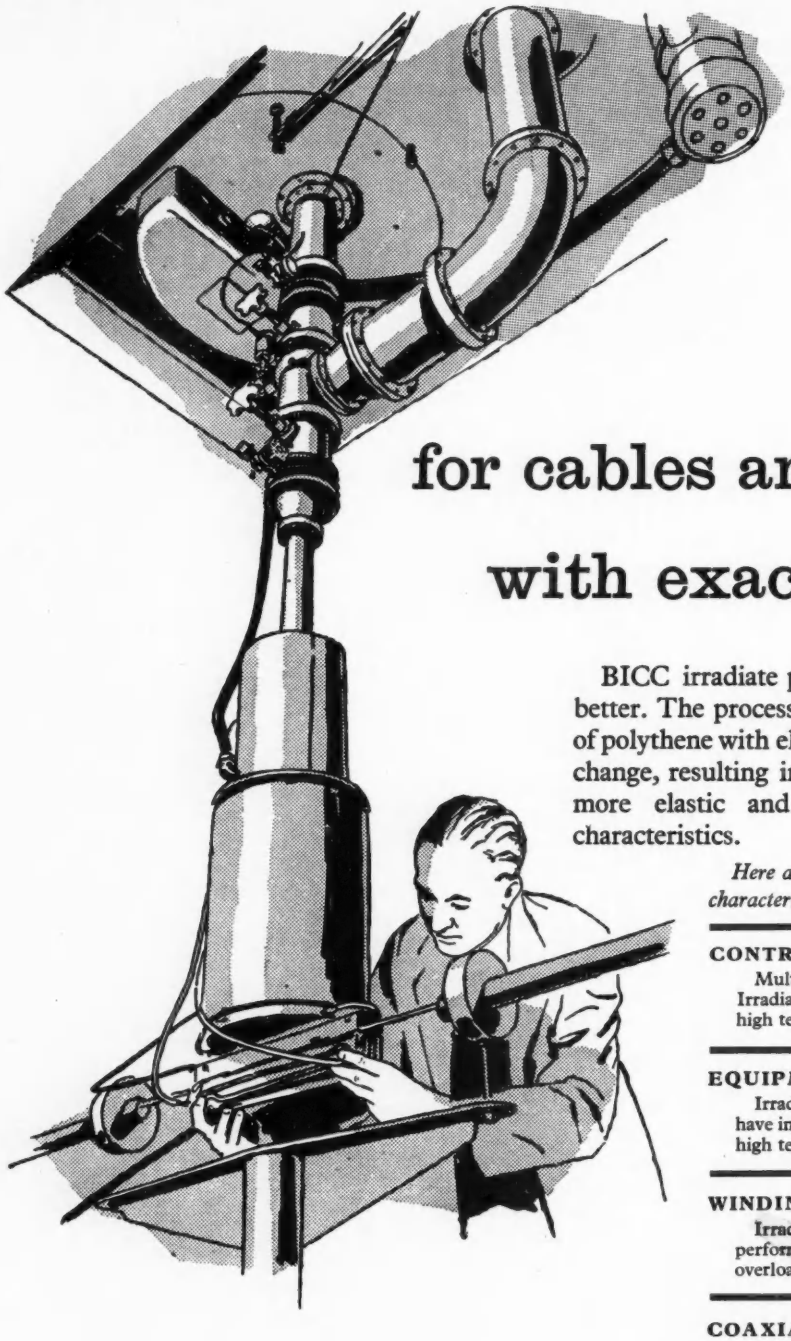
R·E·C·M·F EXHIBITION

STAND
29

PAINTON

Painton & Co. Ltd.

EE 8002 *for further details*



Adjusting the scanning unit of the electron accelerator.

for cables and wires with exacting duties

BICC irradiate polythene to make good cables better. The process is basically the bombardment of polythene with electrons. This causes a chemical change, resulting in a stronger material, which is more elastic and has improved temperature characteristics.

Here are some BICC products with improved characteristics resulting from irradiation:—

CONTROL CABLES

Multi-core cables, insulated and sheathed with Irradiated Polythene, have improved short-term high temperature characteristics.

EQUIPMENT WIRES

Irradiated Polythene insulated equipment wires have improved soldering properties and enhanced high temperature performance.

WINDING WIRES

Irradiated Polythene insulation gives better performance for wires subject to intermittent overload conditions.

COAXIAL R/F CABLES

Irradiated Polythene core permits higher temperature soldering of radio frequency cable terminations.

Full details of these BICC products are available on request.

BICC *IRRADIATED POLYTHENE* **cables & wires**

BRITISH INSULATED CALLENDER'S CABLES LIMITED, 21 BLOOMSBURY STREET, LONDON, W.C.1

Vol. 31 No. 374

APRIL 1959

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E.*

CONTENTS

	Commentary	**191**
	Linear Multi-tapped Potentiometers with Loaded Outputs *by K. C. Garner*	**192**
	Analysis of Impact Noise *by F. M. Savage*	**200**
	Closed Circuit Television Equipment for Advertising Agencies	**203**
	Estimation of Depth of Blemishes in Glass	**203**
	The Recording and Collocation of Waveforms (Part 2) *by R. J. D. Reeves*	**204**
	A New Marine Radar	**212**
	Transistor Amplifier for Magnetic Tape and Drum Playback *by A. E. Bachmann*	**213**
	A Simple Very Low Frequency Oscillator *by J. F. Young*	**218**
	A Stroboscopic Method of Making Frequency Response Measurements *by M. Shepherdson and R. Walters*	**220**
	Regulated Power Supplies *by D. J. Collins and J. E. Smith*	**222**
	A High Stability Electrostatic Generator	**226**
	Telemetering Employing the Principle of the Gas-filled Stepping Tube *by Yoshisuke Hatta*	**227**
	A Three Digit Voltmeter	**229**
	Solid Electrolyte Tantalum Capacitors *by R. Aries*	**230**
	New High Power Transmitters at Ongar	**231**
	Letters to the Editor	**232**
	Book Reviews	**234**
	The Electronic Component Exhibition	**236**
	Short News Items	**241**
	Meetings this Month	**242**
	Publications Received	**242**
FRANÇAIS	**Le Salon Britannique de la Pièce Détachée Electronique**	**243**
	Resumés des Principaux Articles	**247**
DEUTSCH	**Die Ausstellung Britische Bauelemente Für Die Elektronik**	**249**
	Zasammenfassungen der Hauptartikel	**253**

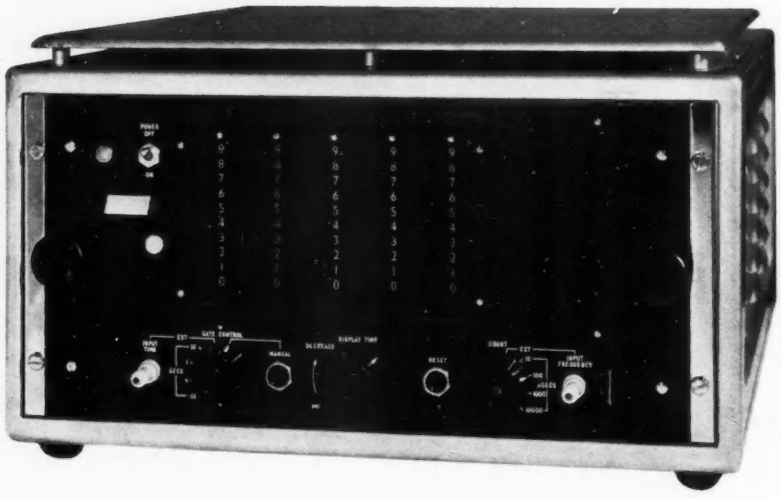
CLASSIFIED ADVERTISEMENTS Page 189 **INDEX TO ADVERTISERS Page 203**

PUBLISHED MONTHLY on the last Friday of the preceding month by:

MORGAN BROTHERS (PUBLISHERS) LIMITED
at 28, Essex Street, Strand, London, W.C.2.
Telephone: CENtral 6565 Telegrams: 'Lectroning, Estrand, London'
Annual Subscription: Home and Overseas £1.16.0 post free, Canada and U.S.A. $5

EE 8003 *for further details*

Build your digital instrumentation systems



round the versatile SA 43/44 UNIVERSAL COUNTER/TIMER

(photograph by kind permission of S. G. Brown Ltd., of Watford.)

An SA.44B/10 is shown here operating with a RACAL MA.51 photo electric probe checking speeds of gyroscopes used in air and marine applications.

**** ANALOGUE OR DIGITAL TIME BASE * 10-SECOND GATE * FACILITIES FOR REMOTE READ-OUT AND PRINTING * 19-INCH RACK MOUNTING * BUILT-IN RELIABILITY WITH PRINTED CIRCUITRY * PLUG-IN UNITS FOR EASE OF SERVICE***

Increasingly, digital counting equipments are being used as integrated parts of a control or instrumentation system. The basic measuring/counting/timing instrument must readily lend itself to a variety of duties and to adaptation and development within the envisaged system.

With the analogue time-based SA.43 (illustrated above) or its digital counterpart, the SA.44, the following functions are offered at low initial cost:

Frequency measurement from 10 c/s to 100 kc/s.

Time interval measurement from 10 microseconds to 1,000 seconds.

Random or regular pulse counting. Using suitable tachometer-transducers shaft speed measurement is also easily performed.

Write for full details of these and other Racal Digital Counting Equipments

INSTRUMENT DIVISION

RACAL

RACAL ENGINEERING LIMITED

Western Road, Bracknell, Berkshire. Telephone: Bracknell 941 Telegrams/Cables: RACAL BRACKNELL BERKS
N. ENGLAND AGENT: Farnell Instruments, Ltd., Wetherby Industrial Estate, York Road, Wetherby, Yorks. Tel: Wetherby 2691/2
SCOTTISH AGENT: A. R. Bolton & Co., Ltd., 3A St. Vincent Street, Edinburgh. Tel: Edinburgh 32035

GUARANTEED TEMPERATURE COEFFICIENT

IMPROVED STABILITY

PROMPT DELIVERY

Alma

PRECISION WIREWOUND RESISTORS

A.I.D. Approved

- Precision Components designed and manufactured for consistent accuracy.
- Specially selected wire is sealed against humidity in a resin which can withstand temperatures of over 100°C.
- Ratings 2W, 1W, ½W, ¼W, with maximum resistances of 10 Megohms, 3 Megohms, 1.6 Megohms and 1 Megohm respectively. Standard tolerances set at 20°C:- 1%, 0.5%, 0.25%, 0.1%, or .01 Ohm whichever is greater.
- Guaranteed temperature coefficient of better than 0.002% per °C up to 300 Kohms. Above 300 Kohms choice of temperature coefficients either better than 0.01% per °C or better than 0.002% per °C.
- Tapped resistors or any special types supplied to Customer's own specification.

TREND TOWARDS MINIATURISATION

To meet the increasing demand for smallness combined with accuracy, ALMA COMPONENTS LIMITED have now developed miniature precision wirewound resistors. We are supplying precision wirewound resistors as high as 1 Megohm to an accuracy of better than 0.1 per cent on a size ¼ in. diameter by 13/16 in. long.

Where highly stable precision resistors of minute dimensions are required please call us in to advise and quote to your specification.

ALMA COMPONENTS LIMITED
551 Holloway Rd., N.19
Telephone : Archway 0014/5.

ARDENTE *make a wide range of*

MINIATURE POTENTIOMETERS AND ELECTRONIC COMPONENTS

The miniature components with the big technical background

Sole Manufacturers and Exporters:
ARDENTE ACOUSTIC LABORATORIES LTD.
8-12 MINERVA ROAD, NORTH ACTON, LONDON, NW10 *Telephone: ELGar 3923*
Suppliers of components and hearing aids to the Government and manufacturers all over the world

R.E.C.M.F EXHIBITION
6th—9th April, 1959
STAND No. 106

EE 8005 *for further details*

A RANGE OF TRANSISTORISED

with these features

★ **FOUR TERMINAL NETWORK**
nominally zero impedance at your circuit. Resistance of interconnecting leads automatically eliminated.

★ **OVERLOAD PROTECTION**
latching relay ensures unit cut out on overload. Fuses protect unit against component failure.

LOW TEMPERATURE RISE
exclusive use of C core transformers.

★ **METERS**
grade 1 E. TURNER ammeter and voltmeter.

WORKMANSHIP
to highest standards, **ROBAND** standards.

PERFORMANCE

IMPEDANCE:	<0.05 ohm
RIPPLE:	<1 m.V

OUTPUT VARIATION: Less than 1 part in 1200 for 7% mains change.

MAINS 200/250V. A.C. (115V models available)

★ Not applicable to sub-units.

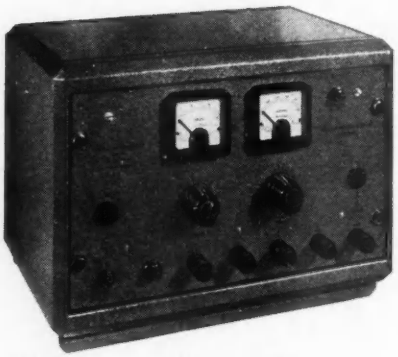
ALL PRICES EX-WORKS

ROBAND

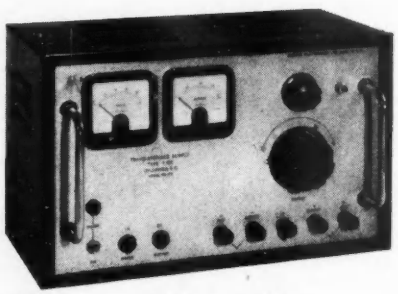
ELECTRONICS LTD.

33 Mountgrove Road, Highbury, N.5

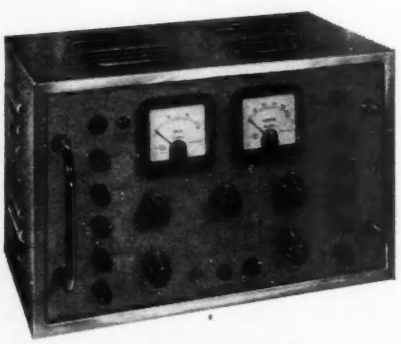
Telephone: CANonbury 4581/8581



MODEL	T101	T103
Output:	0-50V, 1A	0-30V, 1A
Size:	13⅛" x 9" x 9¾" high	
Weight:	17 lbs.	
Price:	£85	£75



MODEL	T102	T105
Output:	0-30V, 2A	0-50V, 2A
Size:	16⅝" x 8" x 10¼" high	
Weight:	35½ lbs.	
Price:	£85	£105

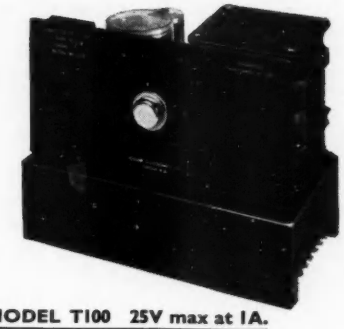


MODEL T104 0-30/0-30V, each section 1A.

Size:	16⅝" x 8" x 10¼" high
Weight:	35½ lbs.
Price:	£118

Basically a centre tapped D.C. supply with independent controls.

REGULATED SUPPLIES . . .



MODEL T100 25V max at 1A.

Size:	7½" x 4" x 5½" high
Weight:	5 lbs.
Price:	£45

MODEL T108 50V max at 1A.

Size:	8½" x 5½" x 6½" high
Weight:	8 lbs.
Price:	£55

MODEL T109 50V max at 2A.

Size:	10½" x 5½" x 7½" high.
Weight:	13 lbs.
Price:	£70

All sub-units are supplied at fixed voltages. Thus a T100/24 is a 24V 1A supply. The output can be readily altered to any fixed voltage within the range.

MODEL T106 0-100V, 1A.

Size:	21¼" x 13" x 11¾" high (Standard 19" x 8¾" panel)
Weight:	50 lbs.
Price:	£135

MODEL T107 0-100V, 2A.

Size:	21¼" x 13" x 11¾" high. (Standard 19" x 8¾" panel)
Weight:	60 lbs.
Price:	£165

Also: A RANGE OF FIXED AND VARIABLE STABILISED SUPPLIES UP TO 500 V
And: A RANGE OF R.F. STABILISED SUPPLIES UP TO 50 K.V.

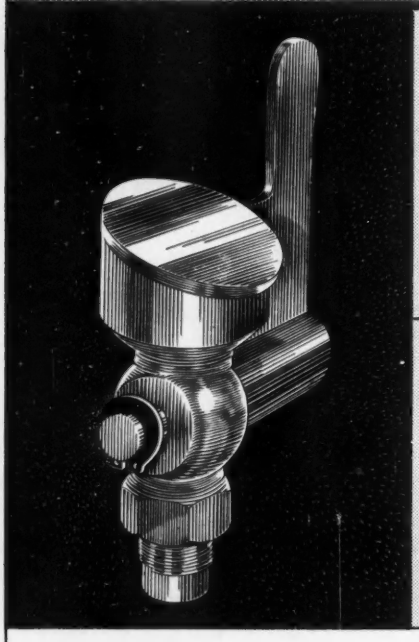
ROBAND

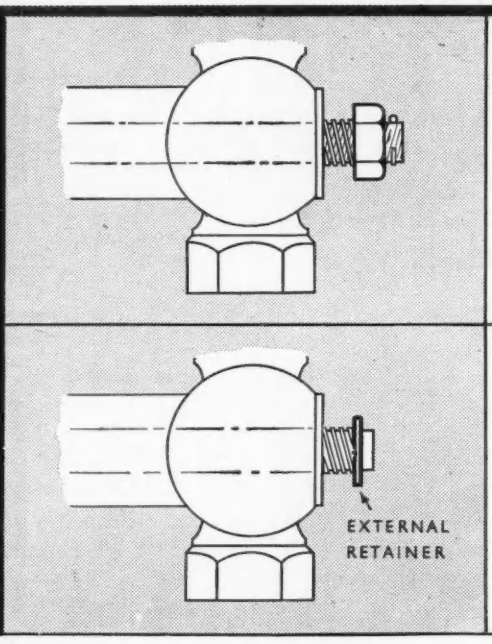
ELECTRONICS LTD.

33 Mountgrove Road, Highbury, N.5

Telephone: CANonbury 4581/8581

The logical advance in Retaining





OLD WAY

To provide a shoulder for the tensioning spring on this filler cup entailed an extra long, threaded shaft, a nut, a hole drilled to take a cotter pin and an altogether tedious assembly.

THE SALTER WAY

The spring is quickly positioned on a shorter, **PLAIN SHAFT** by a ***Grip Ring*** which is snapped into position for secure, frictional grip. No groove required.

save material–reduce assembly time–cut costs

When it's a question of assembling components in any engineering field, Salter Retainers are the answer. They replace nuts and bolts, screws, cotter pins, and eliminate expensive threading and machining operations. A large standard range is at your immediate disposal, and we should welcome the opportunity to assist in developing special retainers to solve your problems.

Send for the Salter Retainer catalogue — no designer is complete without it.

NEATER – MORE POSITIVE – PERMANENT RETAINING

SALTER "TRUARC" Regd Trade Mark

Circlips *Fasteners* *Retainers* *Fixes*

Geo. Salter & Co. Ltd., West Bromwich. *Spring Specialists since 1760*

M-W.444

INSTRUMENTS FOR RESEARCH AND PRODUCTION

RMS
PEAK
AVERAGE
INDICATION
in terms of
db
VOLTS
dbm

Electronic Voltmeter Type (2409) features:

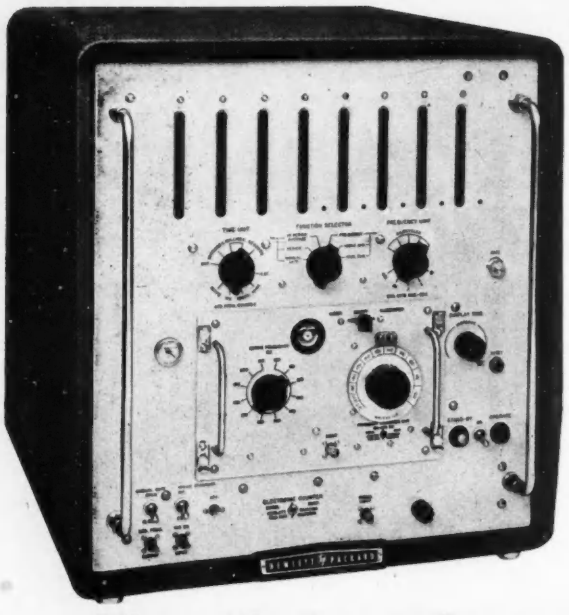
- **Peak, arithmetic average, and true R.M.S. measurements** by means of specially designed rectifier circuits. The accuracy of the R.M.S. indication is better than 0.5 db for signals with crest factors up to 5.
- **Linear frequency response (to within ±0.2 db) from 2 c/s to 200,000 c/s.** Input impedance 10 MΩ in parallel with 20 $\mu\mu$F. To facilitate the use of the instrument as **a calibrated amplifier** it is supplied with screened output terminals. Output impedance: Approximately 50 Ω.
- **Illuminated meter scale calibrated in volts, db with reference to 1 volt and dbm (1 mV into 600Ω).** Sensitivity variable in 10 db-steps from 10 mV to 1000 V full scale deflection.
- **Two different meter damping characteristics,** one of which is in accordance with the standards for VU-measurements, and the other a high damping suitable for measurements of low frequency signals.

Write or phone for further information.

B K **Brüel & Kjær**

Adr.: NÆRUM, DENMARK · Teleph.: NÆRUM 800500 · Cable: BRUKJA, COPENHAGEN
SALES AND SERVICE: B & K Laboratories, 4 TILNEY STREET, PARK LANE, W.1

EE 8010 *for further details*



PRESENTING

HEWLETT-PACKARD

524D ELECTRONIC COUNTER

New 8-decade numerical readout!
New 5/10⁸ per week stability!

SPECIFICATIONS

(Basic 424D without plug-ins)

Frequency:
- **Range:** 10 cps to 10.1 Mc
- **Gate Time:** 0.001, 0.01, 0.1, 1, 10 secs or manual
- **Accuracy:** ± 1 count ± 0.000005%
- **Reads in:** KC, Automatic decimal

Period:
- **Range:** 0 cps to 10 KC
- **Gate Time:** 1 or 10 cycles of unknown
- **Accuracy:** ± 0.3% (1 period)
  ± 0.03% (10 period average)
- **Stan. Freq. Counted:** 10 cps, 1 KC, 100 KC, or 10 MC, or external
- **Reads in:** Secs, msec, μsec

General:
- **Registration:** 8 places (99,999,999 max.)
- **Stability:** 5/100,000,000. May be standardized with WWV or external 100 KC or 1 MC primary standard.
- **Display Time:** Variable 0.1 to 10 secs; or "Hold"
- **Input Voltage:** 1 v min, 1.5 v peak. Rise time 0.2 seconds, max.
- **Input Impedance:** Approx. 1 megohm; 40 μμf shunt.

plus all these frequency and time measuring advantages!

Direct, instantaneous, automatic readings

Frequency coverage 10 cps to 220 MC (with plug-in units)

Time interval 1 μsec to 100 days

Resolution 0.1 μsec

High sensitivity, high impedance

No calculation or interpolation

New convenience of uniform 8-decade numerical readout without meters—new 5 parts in 10^8 stability simplifying standards and other microwave measurements—this is the capsule story of the new *-hp-* 524D Electronic Counter.

Electrically similar to the widely used *-hp-* 524B Counter, the new 524D provides for full frequency measurements from 10 cps to 10 MC and period measurements from 0 cps to 10 MC. Low cost plug-in units extend frequency measuring range to 220 MC, permit period measurements of over 10,000 periods, and increase sensitivity for precise measurement of weak signals. Still another plug-in provides for time measurements from 1 *u*sec to 100 days with 0.1 *u*sec resolution. When used with *-hp-* 540A Transfer Oscillator, the 524D will measure accurately to 12 KMC. For complete details, write or call your *-hp-* representative; or write direct.

HEWLETT-PACKARD COMPANY

Represented by

LIVINGSTON LABORATORIES LTD

RETCAR STREET · LONDON · N.19

Telephone: Archway 6251

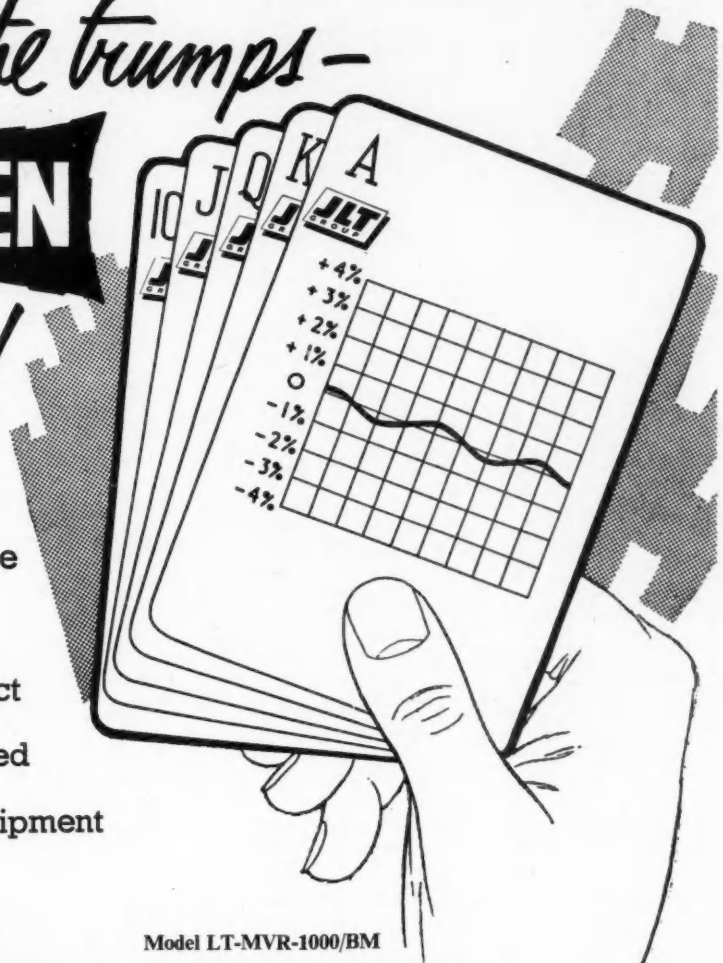
EE 8011 *for further details*

The magnetic A.C. voltage regulators

with all the trumps—

SORENSEN

of course!



(A) Accuracy ± 0·5%

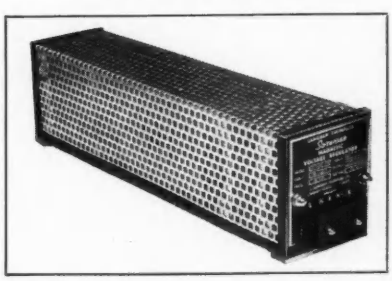
(K) Fast response time

(Q) Low cost

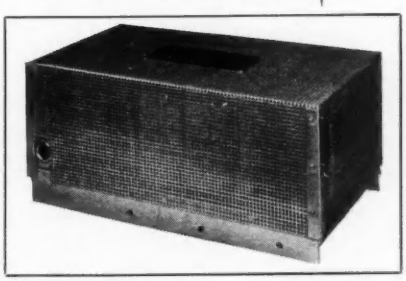
(J) Small and compact

(10) Easily incorporated into standard equipment

Model LT-MVR-120/BM



Model LT-MVR-1000/BM



Input Voltage range 190v — 260v, 50 c/s. Output Voltage (nominal) 228v—232v. Time Constant 20-80 milliseconds. Bench and wall mounting forms are standard, but sub-unit or rack mounting models are also available.

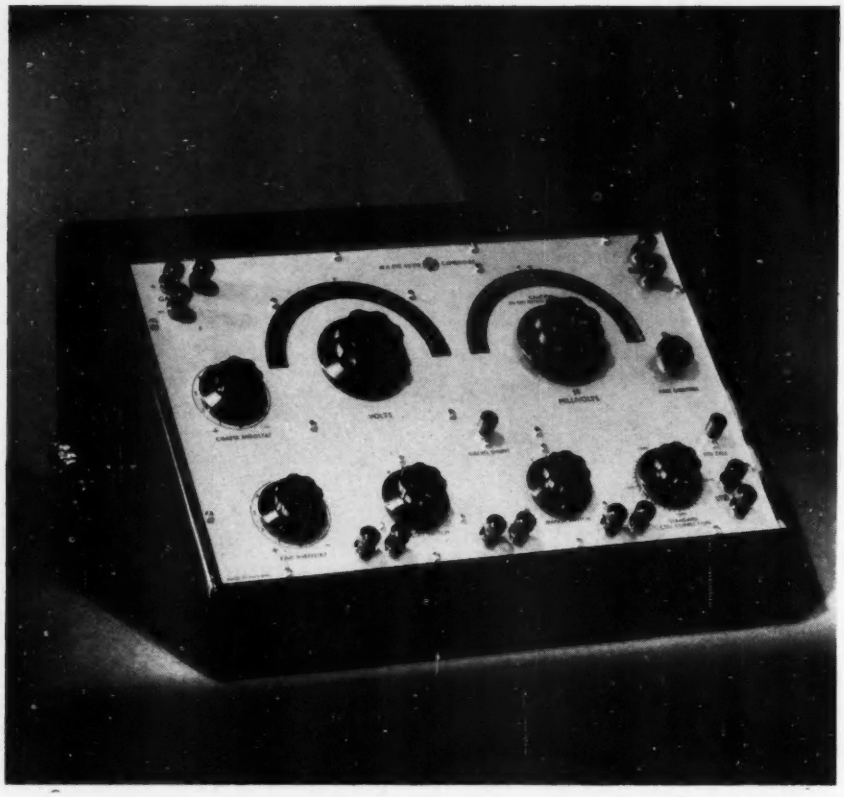
JLT GROUP

J. LANGHAM THOMPSON LTD.

BUSHEY HEATH · HERTFORDSHIRE · ENGLAND

Tel: Bushey Heath 2411 (4 lines). Grams & Cables: "Tommy Watford"

AD/516



PYE POTENTIOMETERS

Where voltage measurements of the highest accuracy are required Pye Potentiometers are the ideal choice.

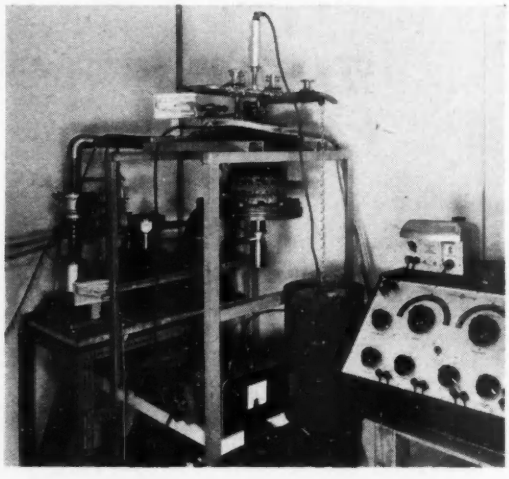
The Pye Precision Vernier Potentiometer (Cat. No. 7568) is intended for use with thermocouples for precise temperature measurement or for the accurate measurements of resistance: it can be used for calibrating potentiometers and standardising currents for electrical measuring instruments. This instrument is ideally suited for submission to the National Physical Laboratories for certification as a laboratory reference standard. No slidewires are used in the measuring circuit and the switches employed are specially designed for long life and very low e.m.f. effects. The range is 0 to 1.901V and the accuracy is $\pm 0.002\%$.

The Pye Universal Precision Potentiometer (Cat. No. 7565), illustrated above, employs an ingenious slidewire device which incorporates the tapper key. This virtually eliminates wear on the slidewire, which maintains its linearity through its very long life. The range is 0 to 1.75V with an accuracy of $\pm 0.02\%$.

For compactness, robustness and convenience in use, the Pye Portable Potentiometer (Cat. No. 7569/P) stands supreme.

All facilities, such as galvanometer, standard cell and accumulator (or dry battery) are built-in. The range is 0 to 1.8V. Multipliers of 0.1 and 0.01 convert each scale division into 100 μV and 10 μV respectively. Accuracy $\pm 0.1\%$ or ± 1 slidewire division.

SCIENTIFIC PYE INSTRUMENTS



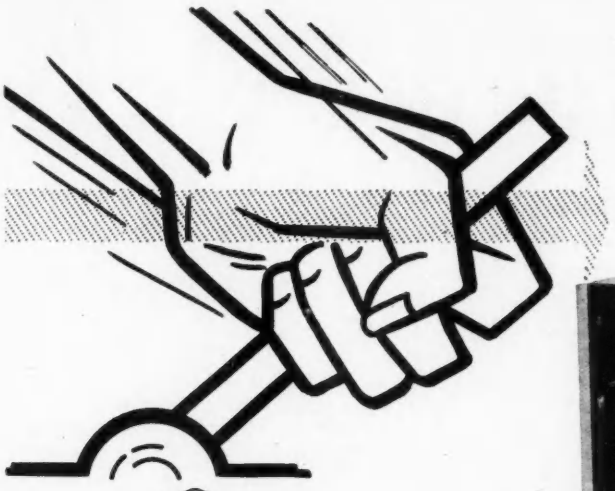
The above apparatus featuring the Pye Universal Potentiometer and Scalamp Galvanometer is being used by the Atomic Energy Division, of the General Electric Co. Ltd. to carry out research into uranium fuel elements.

Please write for full details of these instruments and of any accessories, such as galvanometers, shunts, cells etc. that may be required.

Immediate delivery of a limited quantity is available.

W. G. PYE & CO. LTD., GRANTA WORKS, CAMBRIDGE.

Telephone: Cambridge 54411. *Telegrams: Pye, Cambridge.*

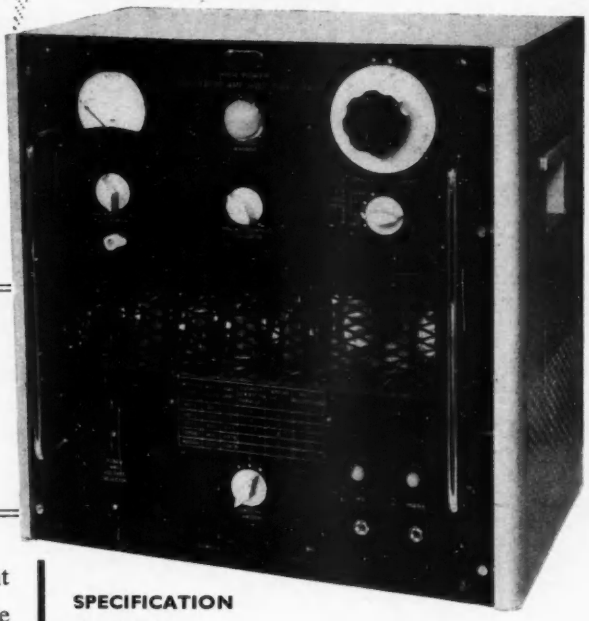


A Source of Power and Drive

AIRMEC

HIGH POWER OSCILLATOR / AMPLIFIER

TYPE 254



The High Power Oscillator/Amplifier is an instrument which combines an L.F. oscillator operating over the frequency range 30 c/s to 30 kc/s with a power amplifier capable of delivering up to 150 watts into a wide range of output impedances. The amplifier output is monitored by means of a built-in Voltmeter and an input socket is provided for use with external signal sources (microphones, pick-ups, signal generators, etc.).

SPECIFICATION

OSCILLATOR

Frequency Range: 30 c/s to 30 kc/s in 3 ranges.
Calibration Accuracy: ±2% on all ranges.

AMPLIFIER

Sensitivity: 0.1 volt r.m.s. input for full output.

MAXIMUM CONTINUOUS POWER OUTPUT *(SINE WAVE)*

150 watts from 50 c/s to 5 kc/s.
100 watts from 30 c/s to 10 kc/s.
50 watts from 30 c/s to 30 kc/s.

THERE'S NO END TO ITS APPLICATIONS

The instrument has a wide variety of uses of which the following are representative :—

- ★ **Power Source for 40, 400, 1600 and 2400 c/s equipments.**
- ★ **Power Source for double voltage, double frequency testing on transformers in accordance with RCS.214.**
- ★ **Drive amplifier for A.C. servomotors.**
- ★ **Energising source for moving coil vibrators.**
- ★ **Modulation amplifier for Radio Transmitters.**
- ★ **High Power Amplifier for Public Address systems.**
- ★ **A power source for laboratory work on variable frequency filter response tests, variation of magnetic amplifier performance with frequency, etc.**
- ★ **Drive for synchronous clocks.**

Airmec

HIGH POWER OSCILLATOR / AMPLIFIERS

AIRMEC LIMITED · HIGH WYCOMBE · BUCKS · Tel.: High Wycombe 2060

EE 8014 *for further details*

Playwear ✻ WORK WEAR

Sketchley **OVERALL SERVICE**

For most jobs in the works and factory, Sketchley can supply free of charge and on loan, coloured overalls, (men's and women's) in a wide range of pleasing styles. Each wearer is individually measured and Sketchley deliver clean garments weekly; repairs are done when necessary (including button replacements) and the garments are replaced when worn out. Firms Badge service now available. Please write for full details.

WHITE OVERALLS
White long coats (for men or women) are now readily available

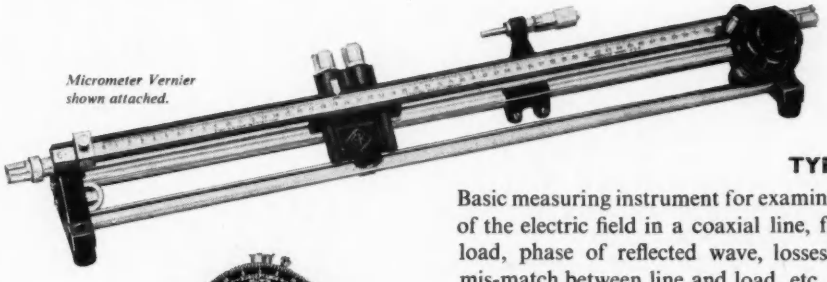
SKETCHLEY LIMITED, FOX GROVE, OLD BASFORD, NOTTINGHAM. Tel. No. NOTTINGHAM 75161

EE 8015 *for further details*

U.H.F. MEASURING EQUIPMENT

With basic measuring instruments, such as the Slotted Line or Admittance Meter, generators, detectors, and a wide range of inter-related coaxial elements, all linked through the ingenious Type 874 connector, 'GENERAL RADIO' offer the scientist and engineer a 50-ohm U.H.F. measuring system that is

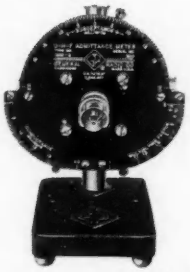
Complete · Integrated · Accurate · Versatile



Micrometer Vernier shown attached.

TYPE 874-LBA SLOTTED LINE:

Basic measuring instrument for examination of the standing-wave-pattern of the electric field in a coaxial line, from which VSWR, impedance of load, phase of reflected wave, losses in attached elements, degree of mis-match between line and load, etc. can be determined. Accurate and straightforward in use. Frequency range 300-5000 Mc/s (with some loss in accuracy: 150-7000 Mc/s). Also available: Type 874-LV Micrometer Vernier (for measurement of high VSWR). Type 874-MD Motor Drive for oscillographic display of standing-wave pattern.



TYPE 1602-B ADMITTANCE METER:

A compact and versatile instrument, accurate and rapid in use, for determining the components of an unknown admittance in the VHF-UHF range. Scales read directly in conductance and susceptance, *independent of frequency*. With unknown connected through quarter-wavelength line, scales read in resistance and reactance. Can be used for measurement of VSWR and reflection coefficient, matching or comparison of impedances, and measurements on balanced line circuits (with the Type 874-UB 'Balun'). Frequency range 41-1500 Mc/s. (Down to 10 Mc/s, with correction). Includes conductance and susceptance standards.

THE GR SYSTEM

Keystone of the entire system is the unique Type 874 coaxial connector, fitted to all elements (see illustration below); this low-loss connector, any two of which, *although identical*, can be plugged together gives the system versatility and ease in setting-up for any measurement, and is characteristic of G-R's clear-sighted engineering philosophy. Low-loss adaptors are obtainable to link up with other systems.

Around this connector G-R have developed a wide range of coaxial elements:— lines, stubs, filters, attenuators, capacitors, inductors, insertion units, ells, tees, terminations, etc., of excellent electrical characteristics. These coaxial elements, together with generators, measuring gear, detectors, 'Balun' (balanced-to-unbalanced transformer) and other instruments form a complete and integrated line of high-frequency measuring equipment, designed for highest accuracy, dependability and convenience in use . . . in keeping with the G-R tradition of supplying only the finest in laboratory equipment.

Identical Type 874 connectors.

Claude Lyons Ltd.

For complete information on G-R U.H.F. measuring equipment, and of the entire range of G-R laboratory gear, apply for Catalogue 'O'.

76 OLDHALL STREET, LIVERPOOL 3, LANCS. TELEPHONE: CENtral 4641-2
VALLEY WORKS, HODDESDON, HERTS. TELEPHONE: HODdesdon 3007-8-9

CL/48/E1A

British-made Newmarket Transistors hold the answer

With the advent of transistors, the solution of ballistic and space travel problems has been enormously speeded up and simplified. Their further development in the next decade may well ordain the shape of many projects yet to come.

If past achievement be any guide, the source from which most future advances will come is predictable. Throughout the *15 years of semiconductor evolution in Britain to date, one name stands out. Besides being the first British company to make available a full range of transistors in production quantities, Newmarket Transistors Ltd were:

FIRST with RF types

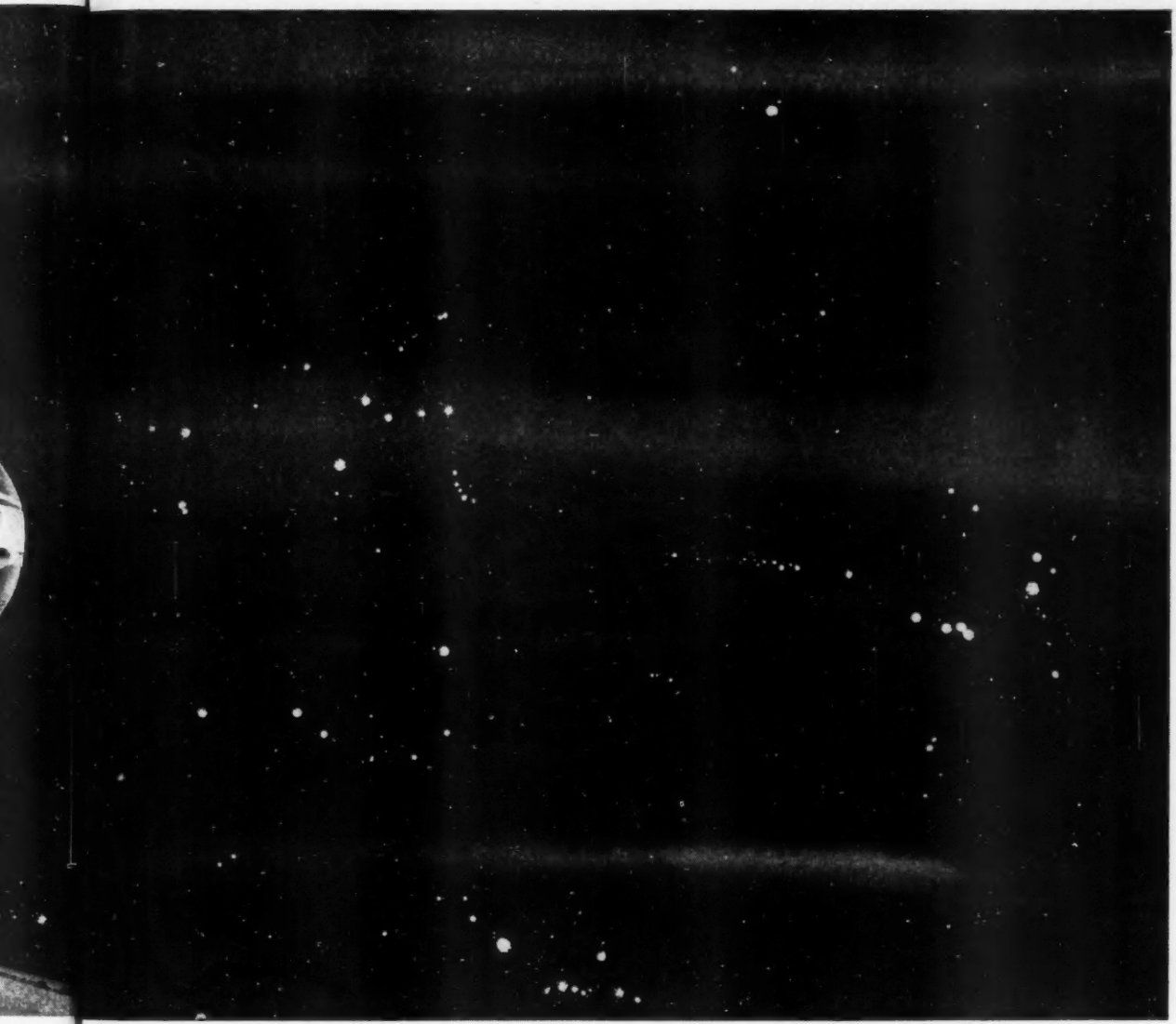
FIRST again with high power output types

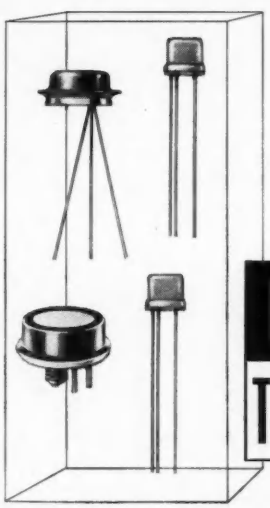
FIRST with intermediate power types

FIRST to supply radio manufacturers with complete matched complements of transistors

* *A Bibliography published by the Company is available on application.*

NEWMARKET TRANSISTORS LIMITED





In addition, early liaison with leading radio and equipment manufacturers enabled Newmarket to supply the transistors used in the first all-transistor portable radio, the first transistorized loud-hailer, the first transistorized car radio.

Thus, and in every possible way, have Newmarket transistors been tested, proved and improved. The calibre of Newmarket's development background, production resources and customer service is without equal in the industry.

When buying transistors, the name Newmarket is your guarantee of dependability—both in performance and supply.

NEWMARKET TRANSISTORS

INTERNATIONAL TRANSISTOR EXHIBITION & CONVENTION

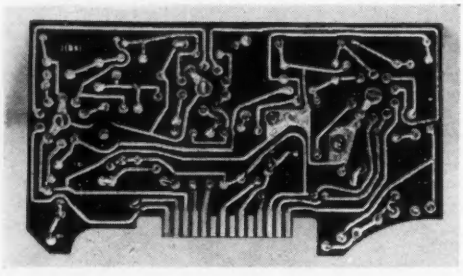
Earls Court May 21st—27th 1959

Anyone interested in new applications and developments of transistors should not fail to visit our stand at this Exhibition.

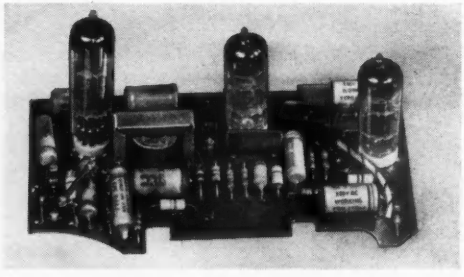
Exning Road, Newmarket, Suffolk Telephone Newmarket 3381 TA1640

VISIT OUR STAND No. 14 AT THE R.E.C.M.F. EXHIBITION

TECHNOGRAPH PRINTED CIRCUITS



Printed Circuit for A. J. Balcombe plug in Time Base Unit made by Technograph.



A. J. Balcombe Plug in Time Base Unit. (Patent Pending)

THE FOUNDATION OF MODERN RADIO, TELEVISION AND ELECTRONIC EQUIPMENT

FOR :—

RIGID TYPE CIRCUITS
FLEXIBLE CIRCUITS
FLUSH BONDED CIRCUITS
RESISTIVE CIRCUITS
RESISTORS
INDUCTORS
HEATING ELEMENTS
STRAIN GAUGES

CONSULT

TECHNOGRAPH ELECTRONIC PRODUCTS LTD.
FLEET, HANTS.
FLEET 1414/7

LONDON OFFICE :—**32 SHAFTESBURY AVENUE, W.I.** **GERRARD 4532/3**

EE 8019 *for further details*

a NEW

HIGH SPEED PANEL MOUNTING ELECTRO-MAGNETIC COUNTER

NOW *with* INSTANT ELECTRIC RESET

★ ***This counter can be supplied with the first wheel graduated 0 to 9 or 0 to 11 as standard.***

This counter embodies all the well-tried features of our Type 100 Electric Counters, plus electric reset. This form of reset is particularly useful where a number of counters are required to be reset at the same time.

Coils for both resetting and counting can be supplied for operation on the following voltages:—

24/48 volts D.C., 110/115 volts A.C., 50 and 60 cycles and 230/250 volts A.C. 50 cycles.

A further model is now available with improved push-button manual resetting facilities which ensure that the counter is virtually sealed.

Write for full details.

FACTORY EQUIPMENT EXHIBITION
EARLS COURT
APRIL 7—17, 1959
SEE OUR EXHIBIT
at Stand No. H. 28

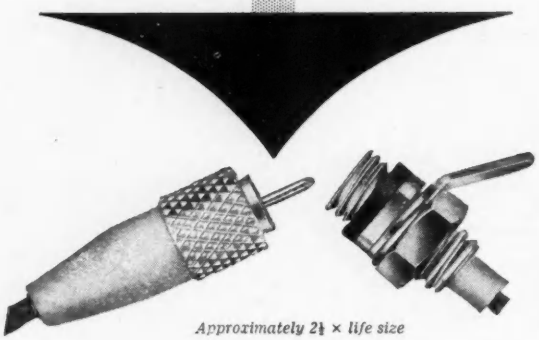
Counting Instruments Ltd

COUNTING INSTRUMENTS LTD. 5 ELSTREE WAY, BOREHAM WOOD, HERTS. Tel: ELStree 1382 (4 lines)

EE 8020 *for further details*

The very best connections ...secured by Plessey

SUB-MINIATURE COAXIAL CONNECTORS



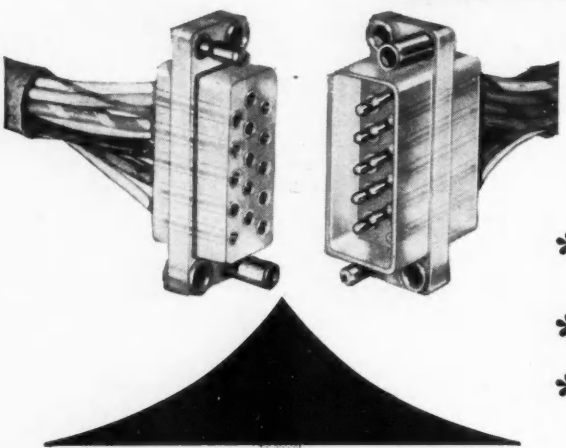
Approximately 2½ × life size

As a contribution towards increasingly compact equipment, Plessey have introduced this new, highest quality and fully comprehensive range to allow a new approach on applications hitherto restricted by the limitations of existing connectors.

Designed for the matched impedance coupling of high frequency coaxial cables operating in the super high frequency bands, these connectors—

* have a working voltage of 650 volts PEAK at sea level, and matched impedance coupling of 50 ohm lines is accommodated.
* have hard gold plated contacts on silver plate to give maximum performance with minimum voltage drop.

SERIES '110' (15- and 30-way) MINIATURE RECTANGULAR CONNECTORS



Developed specifically by Plessey to meet the demand for a safe, inexpensive connector for commercial applications, this new series embodies excellent electrical and mechanical characteristics, and the many unique features that make it really outstanding include:—

* Plug pins and socket inserts are polythene shrouded to dispense with gaskets and ensure insert anchorage.
* Mismating is prevented by corner pins and corner sockets.
* Extreme simplicity of wiring, demands less-skilled operation than the orthodox methods of soldering pins *in situ*.

For further information please write for Publication Nos. 128 and 114

Plessey

ELECTRICAL CONNECTORS DIVISION · THE PLESSEY COMPANY LIMITED
CHENEY MANOR · SWINDON · WILTS · TELEPHONE: SWINDON 6251
Overseas Sales Organisation: PLESSEY INTERNATIONAL LIMITED · ILFORD · ESSEX

CW6

EE 8021 *for further details*

Promoted by the Electronics and Communications Section of
The Institution of Electrical Engineers

INTERNATIONAL TRANSISTOR EXHIBITION

21-27 MAY · EARLS COURT · LONDON

The **INTERNATIONAL TRANSISTOR EXHIBITION** will be held in the same building and at the same time as the *International Convention on Transistors and Associated Semiconductor Devices.*

●

These two events, both promoted by The Institution of Electrical Engineers, are attracting world-wide interest and an overall attendance of some 60,000 is anticipated.

●

The Exhibition will cover all types of semiconductor devices and their numerous applications, and will include transistor materials, equipment involving transistors and semiconductor techniques, and also various associated and specialized components for use in transistorized equipment.

●

Part of the Exhibition will be devoted solely to transistor research and development, and will include exhibits from government, industrial and university research laboratories.

●

Manufacturers wishing to participate in this unique Scientific Exhibition are invited to contact the organizing company.

●

Two thousand scientists and engineers directly concerned with transistors and their application, and coming from all over the world, are expected to attend the International Convention on Transistors, the opening lectures of which will be given by the inventors of the transistor—Dr. W. B. Shockley, Dr. W. H. Brattain, and Professor J. Bardeen.

Full details from the organizers:

INDUSTRIAL & TRADE FAIRS LIMITED
Drury House, Russell Street, London, W.C.2. TEMple Bar 3422

Permanent Magnets

Design Advisory Service

No. 13

Television Applications – 1

Advertisements in this series deal with general design considerations. If you require more specific information on the use of permanent magnets, please send your enquiry to the address below, mentioning the Design Advisory Service.

Television receiver circuits have been greatly simplified by the use of permanent magnets which require no current and do not generate heat. The main applications include focusing, ion traps, beam centring, picture correction and magnetic bias for linearity controls.

TV Focusing

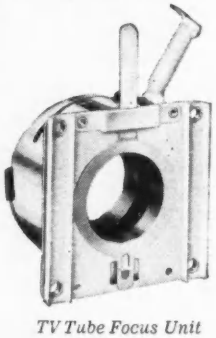
The magnetic focusing of television tubes is achieved by a concentric magnetic field acting as a lens. The focusing action results from the magnetic field which has a rotational symmetry about the axis of the lens.

The focal length f is given by

$$\frac{1}{f} = \frac{0.0347}{V} \int_{z=-\infty}^{z=+\infty} H_z^2 \, dz$$

where V *is the potential difference traversed by the electrons before they enter the lens and* Hz *is the magnetic field strength along the axis.*

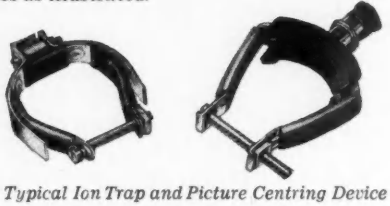
Axially magnetised 'Magnadur' 1 rings can be used for focusing and are mounted on the tube neck so that they repel each other. Rings having peak central fields of between 180 and 250 oersteds will focus tubes with EHT voltages from 9kV to approximately 20kV respectively. Adjustment in the magnetic field is obtained by axial movement of one of the rings. This alters the working point of each magnet, thereby varying the field strength, and also affects the leakage field. The further the magnets are from each other, the stronger the central field inside the rings and the greater the focusing effect. Using this focusing system, picture shift can be made by slight movement of a mild steel ring on the face of the magnet nearest to the screen.



TV Tube Focus Unit

Ion Traps

To avoid ion burn of the screen of a picture tube, the electron gun is set at an angle and a simple magnet assembly giving a uniform diametric field is placed over the neck of the tube about ¼" along the beam. This deflects the electrons through the grid and first anode while the heavier ions are relatively unaffected and strike a suitable target in the electrode assembly, and do not reach the screen. A field between 55 and 70 oersteds is normally required for this beam deflection and is obtained from a small cylindrical magnet, ¾" long and ⅛" in diameter clamped between two mild steel semicircular pole pieces as illustrated.



Typical Ion Trap and Picture Centring Device

Beam or Picture Centring Devices

Magnets of various types are used to provide the magnetic field necessary to correct or shift the electron beam, so that when it has passed through the deflection coils, the picture is central on the screen. Usually the field required varies between zero and 10 oersteds.

'Pin-Cushion' Correction

To achieve good overall focus on 90° and 110° picture tubes, it is advantageous to have a pin-cushion shaped raster. The raster shape can be corrected by magnets placed one on each side of the deflection coils. 'Magnadur' 1 rod magnets 1¼" long x ⅛" dia. magnetised axially are normally adequate to correct this type of distortion.

By suitable choice of magnets and steel pole pieces, it is possible to increase the line scan width. This technique can be used as a means of making small adjustments to the line width.

Linearity Controls

A further use for permanent magnets is to provide the magnetic field to bias a Ferroxcube rod on which the linearity coil is wound. Adjustment in linearity can easily be made by moving the magnet so varying the degree of magnetisation of the Ferroxcube rod. A neat arrangement uses a 'Magnadur' tube approximately 1¼" long x ¼" dia. with the Ferroxcube rod situated inside and the coil being wound on the end of this rod.

If you wish to receive reprints of this advertisement and others in this series write to the address below.

Mullard

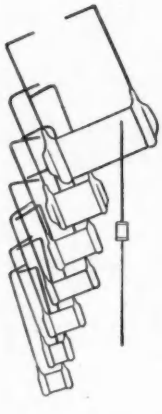
'TICONAL' PERMANENT MAGNETS
'MAGNADUR' CERAMIC MAGNETS
FERROXCUBE MAGNETIC CORES

See us at the R.E.C.M.F. Exhibition
Stand 77
Grosvenor House

MULLARD LIMITED, COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1. LANgham 6633
MC274

EE 8023 *for further details*

'Ohm' on the range



***Yes sir*, they're a bright lot of boys down Rivlin way—proud and friendly, keen as mustard and *mighty* partic'lar. Mighty particular about the Rivlin Range, that is—the range of eight precision wirewound resistors, from ⅛w to 3w, that now covers most normal requirements. Additionally, special types, higher ratings and American equivalents can be supplied to order. But if it bears the name Rivlin, it is a fine piece of skilled design and craftsmanship. Ohm from ohm there's nothing like the Rivlin service. No sirree!**

- *Accuracy up to ±0·1 per cent or ±0·01 Ω, whichever is the greater.*
- *All values available in the range 0·1 Ω to 3 Meg. ohm, with a temperature coefficient of 0·002 per cent °C.*
- *Ratings ⅛w-3w in 8 sizes.*
- *Low-Inductance windings available in most sizes.*
- *Special Types, higher ratings and American equivalents to order.*

RIVLIN—the 'Ohm' of reliability

RIVLIN PRECISION WIREWOUND RESISTORS

RIVLIN INSTRUMENTS LIMITED

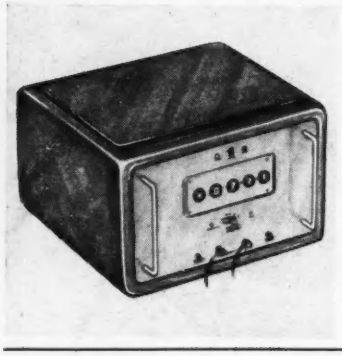
ELECTRONIC ENGINEERS

RIVLIN INSTRUMENTS LIMITED
DOMAN ROAD, CAMBERLEY, SURREY
Telephone: CAMBERLEY 2507/8
London Office· Tel. Swiss Cottage 3038

BLACKBURN INDUSTRIAL ELECTRONICS

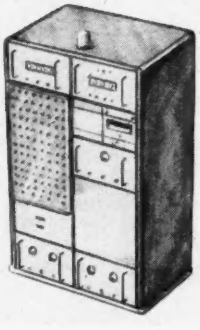
Introducing a complete new range of Industrial Data Handling Equipment

Digital Voltmeters types BIE. 23 and BIE. 24



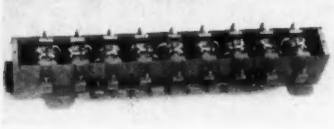
- ★ All electronic—new counting tube.
- ★ Decimal in-line display.
- ★ Accuracy ± 0.05% (BIE.24) and ± 0.1% (BIE.23).
- ★ 103 m. sec. (BIE.24) and 13 m. sec. (BIE.23) conversion time.
- ★ 3 readouts per second.
- ★ Automatic range and sign selection with indication.
- ★ 500 K. Ohm minimum input impedance.
- ★ In-line printer drive.

Blackburn Data Logger BIE. 51



- ★ Up to 1,000 inputs.
- ★ Scanning time per 50 inputs 10 seconds.
- ★ Analogue to digital conversion time 10 m. secs.
- ★ Accuracy ± 0.1%.
- ★ Print out time 200 m. secs.
- ★ In-line printer 11 digit capacity.
- ★ Automatic testing facilities.
- ★ Audible and visual alarm signal.
- ★ Automatic "stop" signal.

Pressure Transducer Bracket Type BIE. 19.



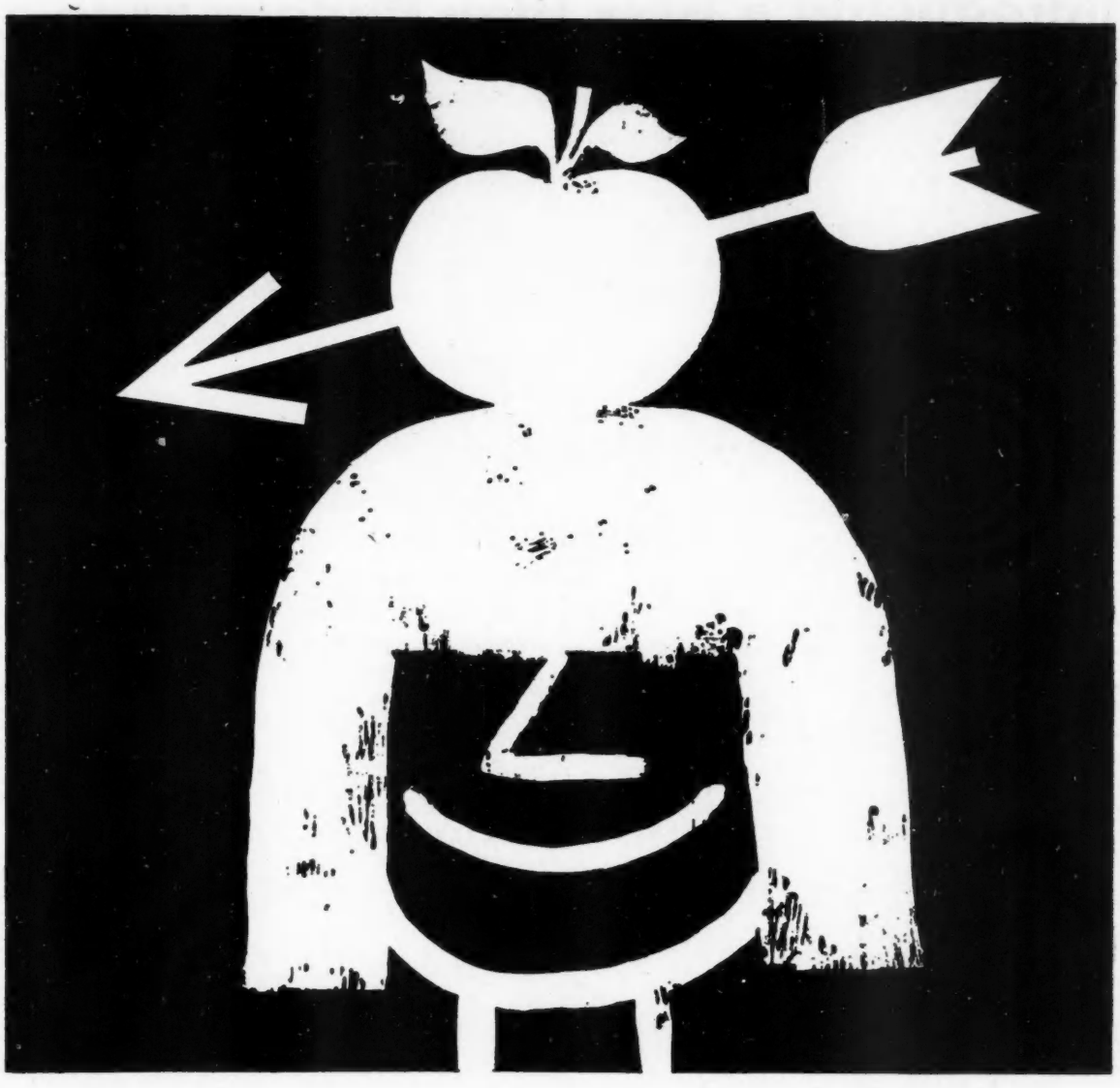
- ★ Pressure range ± 5 p.s.i. to ± 2,000 p.s.i.
- ★ Linearity and accuracy better than ± 1%.
- ★ Output change per g 0.02% of full scale.
- ★ Output change per °C. 0.03% of full scale.
- ★ Output impedance 10 K. Ohms.
- ★ Output current 12 micro-amps per 10% change in pressure.
- ★ Suitable for driving galvanometer recorder.

Write for Full Details to

COMMERCIAL ELECTRONICS DIVISION

BLACKBURN AND GENERAL AIRCRAFT LTD.

BROUGH, YORKSHIRE **TEL: BROUGH 121 (8 LINES)**



Metropolitan Plastics Limited

We'd like to see him do it again ..... please don't think we're morbid but working as we are to the highest standards of precision as a daily routine, we naturally have an interest in such things. If precision work (in thermo-setting plastics) is what you're looking for, plus the capacity to turn out a job bang on time, you'll be sure to find it with; Metropolitan Plastics Limited.

CERTIFIED ZINC ALLOY ZAMCA DIE CASTERS

Glenville Grove Deptford London SE 8 Telephone TIDeway 1172 *Specialists in Thermo-setting Plastics*

EE 8026 *for further details*

Introducing a New High Performance Cascode Amplifier

For the information of set designers we are publishing details of several of our valves for TV circuits. If you are a TV manufacturer we shall be pleased to supply full technical details of any of these valves, together with valves for testing, on receipt of your enquiry. Reprints of advertisements dealing with other valves, mainly in our 'First Preference' Range of individual 0.3 amp heater valves, are available on request.

The valve dealt with in this advertisement is the Type 30L15, a new high performance cascode amplifier.

EDISWAN MAZDA 30L15

The 30L15 is a V.H.F. twin triode specially designed for use as a cascode amplifier in television tuners where a high gain and good noise performance are required. The 30L15 will provide a gain improvement of 4 to 5 dB and a noise factor improvement of 2 dB as compared with the 30L1.

Heater Current (amps)	I_h	0.3
Heater Voltage (volts)	V_h	7.0

MAXIMUM DESIGN CENTRE RATINGS

Anode Dissipation, either section (watts)	$P_{a(max)}$	2.0
Cathode Current, per section (mA) ...	$I_{k(max)}$	16.0
Anode Voltage (volts)	$V_{a(max)}$	250
Negative Grid Voltage (volts)	$V_{g(max)}$	−50
Grid to Cathode Resistance, section 1 (kΩ)	$R_{g'-k'(max)}$	500
Grid to Cathode Resistance, section 2 (kΩ)	$R_{g''-k''(max)}$	22*
Effective Grid to Earth Resistance, section 2 (kΩ)	$R_{g''-E(max)}$	150**

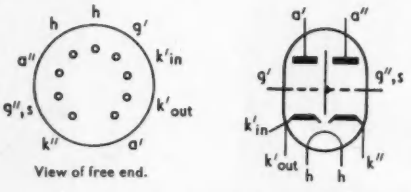
** Grid current bias.*
*** With potentiometer bias from anode supply.*

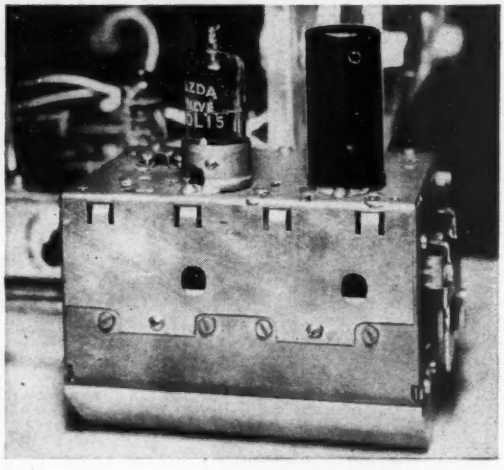
INTER-ELECTRODE CAPACITANCES (pF)†

Grid 1 to Anode 1	$c_{g'-a'}$	1.5
Anode 1 to Cathode 1, Heater, Shield ...	$c_{a'-k',h,s}$	1.9
Grid 1 to Cathode 1, Heater, Shield ...	$c_{g'-k',h,s}$	3.1
Anode 2 to Cathode 1, Heater, Shield ...	$c_{a''-k',h,s}$	3.6
Grid 1 to Anode 2	$c_{g'-a''}$	0.0058

† Inter-electrode capacity with holder capacity balanced out but with cylindrical screen can.

BASE:
NOVAL—B9A





MAXIMUM DIMENSIONS

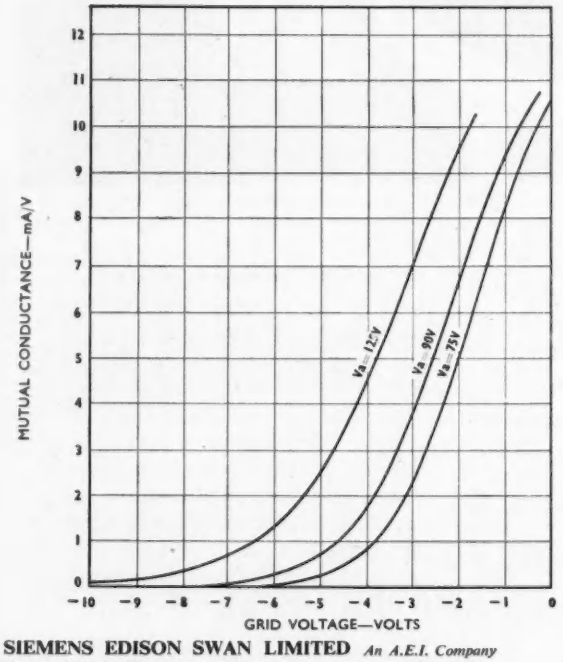
Overall Length (mm) 56 Seated Height (mm) 49
Diameter (mm) 22.2

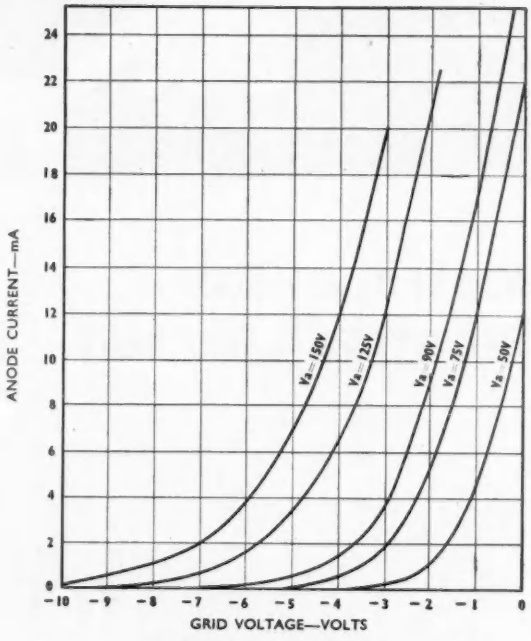
TYPICAL CASCODE OPERATION

Conditions given for circuit with the second section using potentiometer bias from the anode supply, making $V_{g''-E} = 99$ V.

Anode supply voltage (volts)	$V_{a(b)}$	200
Anode decoupling resistor, section 2 (kΩ)	$R_{a''}$	2.2
Anode current (mA)	I_a	15.3
Self bias resistor, section 1(Ω)	$R_{g'}$	100
Mutual conductance, section 1 (mA/V)...	g_m	8.8
Combined mutual conductance (mA/V)		8.5
A.G.C. Voltage (volts) to give $\Delta I_a \Delta V_{g'}$ = 0.1 mA/V	$V_{g''}$	−7
Input capacity working (pF)	$C_{in(w)}$	6
Change in input capacity by biasing to cut-off (pF)	Δc	1.2

Characteristic Curves of Ediswan Mazda Valve Type 30L15—each section





SIEMENS EDISON SWAN LIMITED *An A.E.I. Company*
Technical Service Department, 155 Charing Cross Rd., London. W.C.2.
Telephone: GERrard 8660. Telegrams: Sieswan, Westcent, London.

EDISWAN
MAZDA

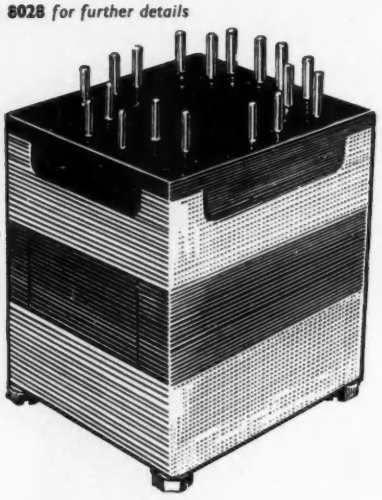
CRC 15/36A

See us on Stand Numbers 53 and 144 at the R.E.C.M.F. Exhibition

MARCONI
Telecommunications
The post and telegraph authorities of more than 80 countries use Marconi equipment
Electronics for Aviation
More than 50 Civil Airlines and 30 Air Forces use Marconi radio, radar and navigational aids
Television
18 countries rely on Marconi Television Transmitting or Studio Equipment
Broadcasting
80 countries rely on Marconi broadcasting equipment
Radar
29 countries use Marconi Radar
MARCONI
COMPLETE SYSTEM PLANNERS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND
M.8

EE 8028 *for further details*



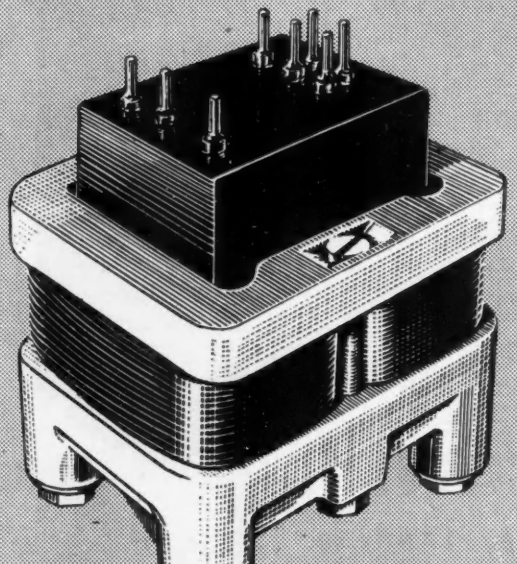
R120 and R130 laminated series.

FORTH SERIES

TRANSFORMERS AND CHOKES

smaller in size – lighter in weight

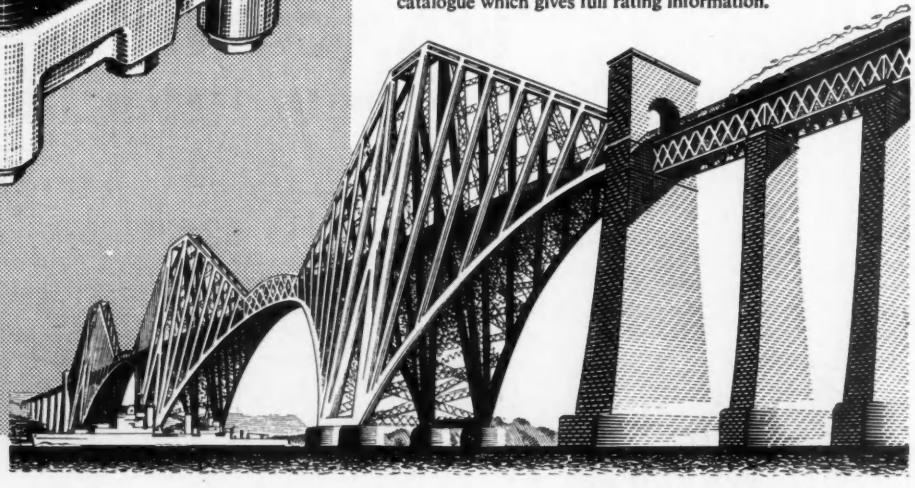
R200 'C' Core series.



FERRANTI

The new range of Ferranti Resin Cast Transformers and Chokes has been named after this famous Scottish landmark which represented a remarkable advance in engineering design when it was constructed over 60 years ago. To-day, the new techniques in manufacture and construction of 'C' Core Transformers have enabled Ferranti Ltd. to make a significant contribution to Electronic Engineering.

The Forth series components will have particular appeal to designers of airborne equipment since savings in weight and volume of up to one-third can be achieved over the resin cast and oil-filled units now available. Moreover, the quality requirements of the Joint Service Specification RCS.214 are met in every respect. Please write for a catalogue which gives full rating information.



FERRANTI LTD • FERRY ROAD • EDINBURGH 5

ES/T41

MS

Silicone Electrical Insulating Materials

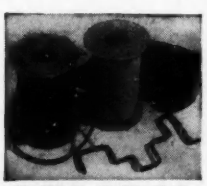
Silicone Resins for Resistor Coatings

A tapped, mains-dropping, wire-wound resistor coated with a cement based on MS silicone resin.

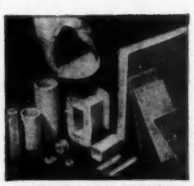
Heat-resistant cements based on MS silicone resins are used to coat wire-wound resistors and are capable of operation at temperatures up to 300°C. These cements are thermo-setting silicone resins filled with inorganic material such as mica flour, amorphous silica, asbestos flour and may be coloured by incorporating heat-stable pigments. Hard, heat-resistant and water-repellent coatings are formed by curing the cement at 250°C. This temperature is much lower than that used for standard heat-resistant coatings and as a result the reject rate is considerably minimised.

Write for Silicone Notes L 21 which gives processing information and recommended formulations.

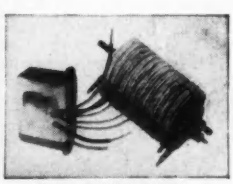
Other Electrical Insulating Materials employing MS silicones include:



SILASTOMER COATED GLASS BRAID FLEXIBLE SLEEVING



SILICONE RESIN BONDED GLASSCLOTH LAMINATES



SILICONE COLD-CURING RUBBER

MIDLAND SILICONES LTD

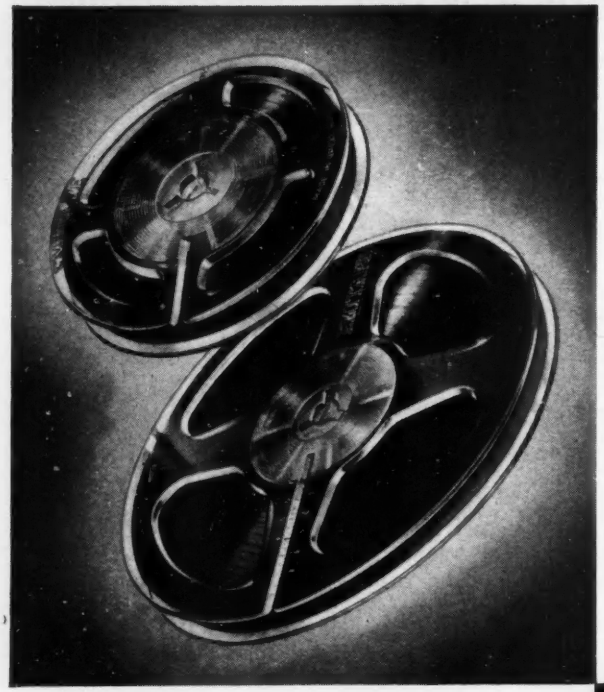
first *in British Silicones*

Associated with Albright & Wilson Ltd., and Dow Corning Corporation

48 KNIGHTSBRIDGE · LONDON SW1 · KNIGHTSBRIDGE 7801 · **Area Sales Offices:** *Birmingham · Glasgow · Leeds · London · Manchester* · **Agents** in many countries

raw/ms119

Emitape

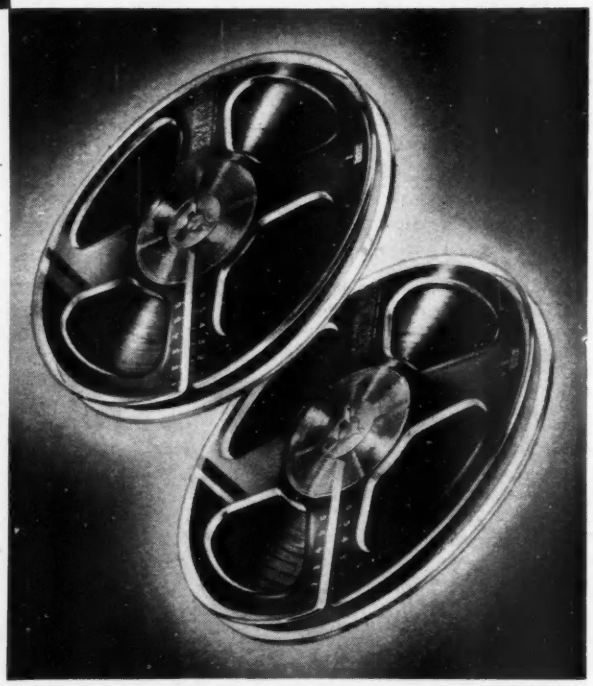


the magnetic recording tape with the highest technical standards

* High sensitivity
* Low noise level
* Low 'print through' factor
* Anti-static
* Freedom from curl and stretch

"88" GENERAL PURPOSE **"99" LONG PLAY**

Type No.	Title	Size	Length approx.	Price in EMICASE	Price without EMICASE
88/3	"Message"	3" dia.	175′	—	7 6
99/3		3" dia.	250′	—	9 6
88/3N		3¼" dia.	175′	—	7 6
99/3N		3¼" dia.	250′	—	9 6
88/6	"Junior"	5" dia.	600′	£1 3 6	£1 1 0
99/9		5" dia.	850′	£1 10 6	£1 8 0
88/9	"Continental"	5¾" dia.	850′	£1 10 6	£1 8 0
99/12		5¾" dia.	1200′	£1 17 6	£1 15 0
88/12	"Standard"	7" dia.	1200′	£1 17 6	£1 15 0
99/18		7" dia.	1800′	£2 12 6	£2 10 0
88/18	"Professional"	8½" dia.	1750′	—	£2 17 6
99/24		8½" dia.	2400′	—	£3 12 6



Emicase

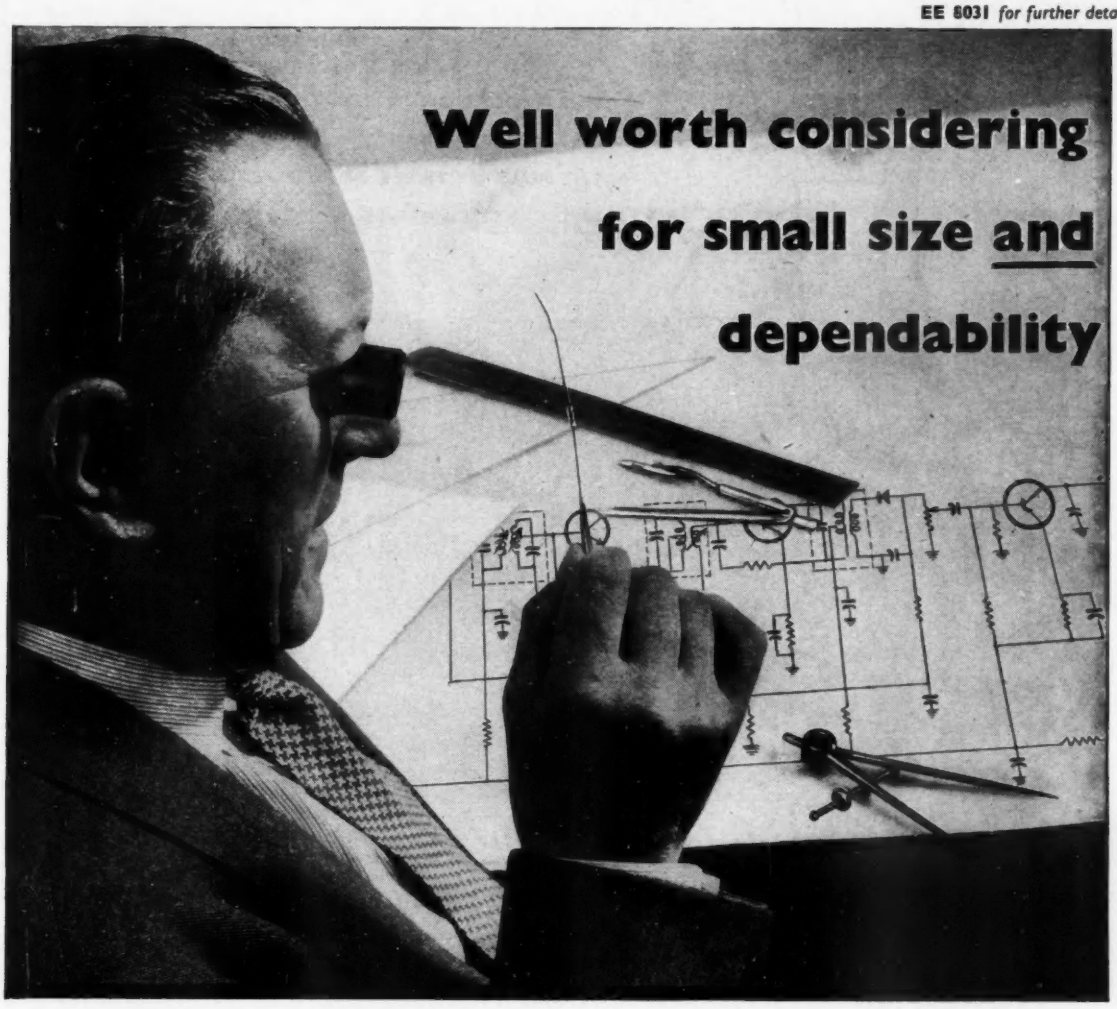
now available separately!

the polystyrene container that solves tape storage problems, protects spools from dust and allows easy identification of leader tapes.

7"—4s. 0d; 5¾"—3s. 6d; 5"—3s. 6d.

E·M·I SALES & SERVICE LTD
(Recording Materials Division)
HAYES · MIDDLESEX
Tel: SOUthall 2468

EE 8031 *for further details*



The new type BTH Germanium Point Contact Rectifiers—

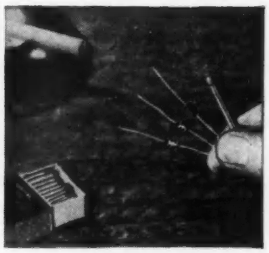
Only ¼ in. long, yet their miniature size is combined with high performance and complete dependability! They offer the following outstanding characteristics:

- **HIGH TEMPERATURE STABILITY**
- **ABILITY TO WITHSTAND TROPICAL CONDITIONS**
- **SMALLER DIMENSIONS**
- **VERY LONG LIFE**

RATINGS: CONTINUOUS OPERATION AT 25°C. (77°F.)

TYPE	PEAK INVERSE VOLTAGE† V	MAX. INPUT CURRENT mA	MAX. RESISTANCE at + 1 volt ohms	MIN. RESISTANCE at − 50 volts kilohms
CV 448*	80	30	333	500
CG41–H	65	30	250	50
CG42–H	100	30	500	1,000
CG44–H	80	30	333	500
CG50–H	100	30	500	200

*Type CV 448 has been granted 'type approval'. †Corresponds to 1·2 mA inverse current.



B T-H

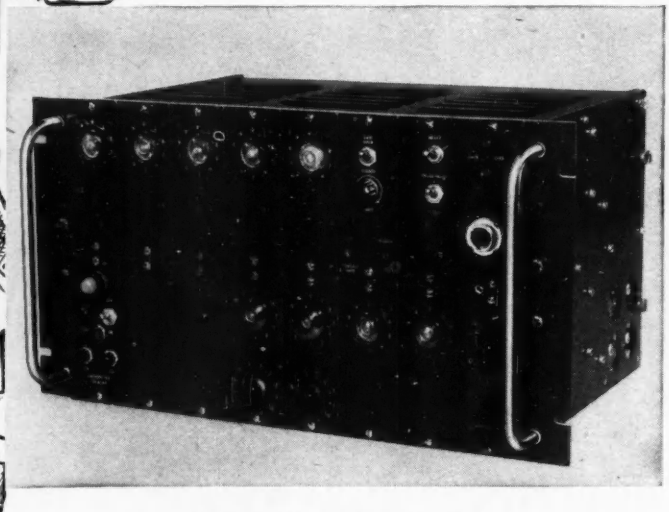
BRITISH THOMSON-HOUSTON

THE BRITISH THOMSON-HOUSTON CO·LTD·LINCOLN·ENGLAND

an A.E.I. Company

A 5162

"MULTIPLICATION IS VEXATION
DIVISION IS AS BAD
THE RULE OF THREE DOTH PUZZLE ME
AND PRACTICE DRIVES ME MAD!"



Tachometer Type 144A—constructed from Plug-in Counting Sub-Units.

The quaint complaint of the Elizabethan schoolboy might well re-echo today where management have not yet realised the significance of modern digital counting techniques.
Many industrial control problems can be interpreted in terms of counting, timing or measuring. To meet these requirements we have introduced a wide range of inexpensive plug-in counting sub-units. These units, of which there are over 50, can be combined to produce dependable equipment for applications ranging from simple counting and batching to complex digital control.
If you want facts-in-figures get in touch with us now.

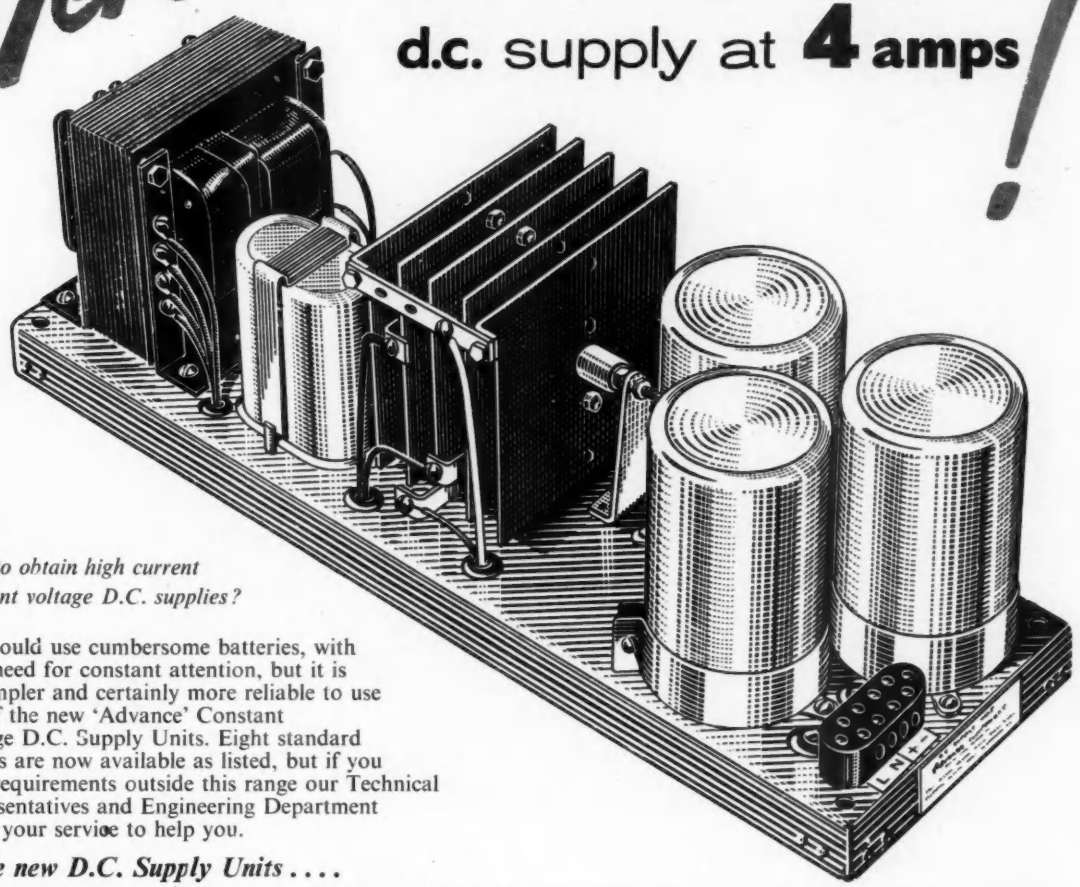
ERICSSON

INSTRUMENT DIVISION
High Church Street · New Basford · Nottingham Tel: 75115

ERICSSON TELEPHONES LTD · HEAD OFFICE · 22 LINCOLN'S INN FIELDS · LONDON W.C.2

PEOPLE WHO COUNT USE ERICSSON EI04-62

Here is a 12v. stabilized d.c. supply at 4 amps!



How to obtain high current constant voltage D.C. supplies?

You could use cumbersome batteries, with their need for constant attention, but it is far simpler and certainly more reliable to use one of the new 'Advance' Constant Voltage D.C. Supply Units. Eight standard models are now available as listed, but if you have requirements outside this range our Technical Representatives and Engineering Department are at your service to help you.

These new D.C. Supply Units . . . .

- Provide **HIGH CURRENT OUTPUT AT LOW COST**
- Are **SMALL IN SIZE AND WEIGHT FOR VA OUTPUT**
- Have **HIGH ENERGY RESERVOIR,** thus are suitable for pulse, intermittent or variable loads
- Operate with **HIGH EFFICIENCY**

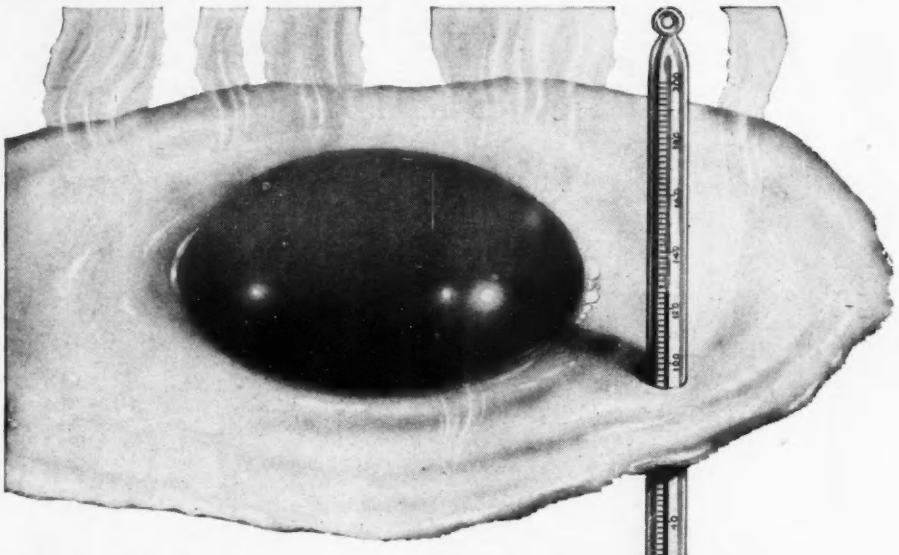
TYPE	OUTPUT RATINGS		NETT PRICE in U.K.
DC/6/1.25	6 volts	1.25 amp	£15
DC/6/4	6 volts	4.00 amps	£25
DC/12/1.25	12 volts	1.25 amp	£20
DC/12/4	12 volts	4.00 amps	£30
DC/24/1	24 volts	1.00 amp	£25
DC/24/5	24 volts	5.00 amps	£45
DC/48/1	48 volts	1.00 amp	£35
DC/48/4	48 volts	4.00 amps	£60

Advance CONSTANT VOLTAGE

D.C. POWER SUPPLIES

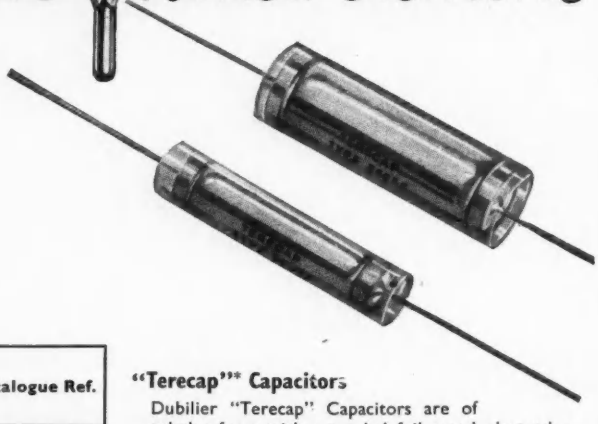
Full technical details available in Leaflet M 59

GD.77 **Advance** COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444



When it's hot enough to fry an egg

"Terecaps" are in their element



SIZES AND RATINGS

Capacitance	Working Voltage d.c. at 71°C	Working Voltage d.c. at 125°C	Test Volts d.c.	Dimensions ins. Length	Dimensions ins. Dia.	Catalogue Ref.
0.1	150	125	300	1 1/2	1/4	8801.C
0.25	150	125	300	1 7/8	1/4	S-8803.C
0.5	150	125	300	1 3/8	3/8	S-8800.C
1.0	150	125	300	1 7/8	3/4	S-8804.C
0.1	250	180	500	1 1/2	1/4	8801.C
0.25	250	180	500	2 1/8	1/4	8803.C
1.0	250	180	500	2 1/8	3/4	8804.C
0.1	350	250	700	1 5/8	1/4	8802.C
0.25	350	250	700	1 7/8	3/4	S-8804.C
1.0	350	250	700	2 1/8	1	8806.C

Other capacitance values can be supplied to order. We invite your enquiries

"Terecap"* Capacitors

Dubilier "Terecap" Capacitors are of tubular form with extended foil metal electrodes fitted with wire tail terminations and incorporate a non-hygroscopic film dielectric. Being designed to meet abnormal atmospheric conditions such as obtain in tropical zones the capacitors are supplied hermetically sealed in metal containers with ceramic end-seals.

* *A Registered Dubilier Trade Mark.*

Dubilier "Terecap" Capacitors have these outstanding features:—

1. Can be used up to 125°C. with voltage de-rating above 70°C.
2. High insulation resistance, more than twenty times that of paper dielectric capacitors. (10,000ΩF at 20°C).
3. Compactness.
4. Excellent capacitance stability over a wide temperature range. (Normal capacitance tolerance ± 20%)
5. Power Factor 0.5% at 20°C. for 1 kc/s.

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, NORTH ACTON, LONDON, W.3.

JR

NICKEL SILVER
AND
CUPRO-NICKEL

For Electronics, Radio & Telecommunication Fields . . . . . .

NICKEL SILVER All qualities from 5% Nickel content to 30% Nickel content.

CUPRO-NICKEL All qualities from 5% Nickel content to 45% Nickel content.

SHEET Maximum width 24". Minimum thickness 0·006".
STRIP Maximum width 18". Minimum width ¼". Minimum thickness 0·005".
WIRE Maximum diameter ½". Minimum diameter 0·0025".

Specialities High finish Nickel Silver Telephone Strip and Sheet conforming to BSS 1824, or to your own specifications for the manufacture of Spring contacts, Relay blades, etc.

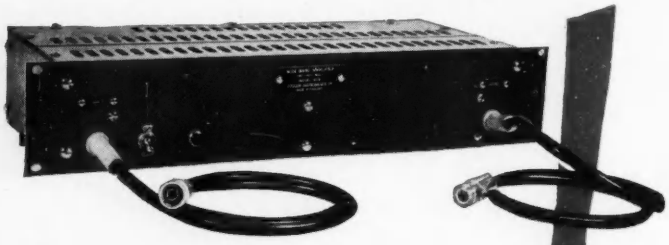
We also specialise in producing Copper-Nickel Alloys (Cupro Nickel) with special resistance properties in the form of Sheet, Strip and Wire.

Established 1845

JONES ROOKE

JONES & ROOKE (1948) LTD. NORTHWOOD STREET ROLLING MILLS, BIRMINGHAM 3.

Voltage Amplifiers



MODEL 1439 WIDE-BAND AMPLIFIER

for TV and VHF distribution systems.
The Amplifier is designed to provide simultaneous distribution of signals anywhere in Bands I, II and III, enabling a common aerial to be used for a number of television or VHF radio receivers or other applications requiring a wide band voltage amplifier.

Voltage gain: 20dB at 60 Mc/s.
Bandwidth: better than 40 Mc/s—220 Mc/s.
Output voltage: 3V pk-pk max.
Input and output impedance: 72Ω (matched coaxial).

MODEL 1440 PRE-AMPLIFIER

This instrument is a directly coupled pre-amplifier of high stability which has been designed for use in cascade with a further amplifier or with a recording device.

Frequency response: d.c.: 0—50kc/s, a.c.: 5c/s—50kc/s.
Gain: continuously variable 10-55 (d.c.), 165 (a.c.)
Input: balanced or unbalanced, impedance 11.2MΩ (grid-grid.)
Output: balanced or unbalanced, impedance 2000Ω (output 1—output 2).
Output voltage: 5V pk-pk max. (output 1—output 2).
Calibration signal: 1mV or 10mV.

MODEL 1442 LABORATORY HIGH-GAIN AMPLIFIER

Model 1442 has been designed for use in the Laboratory and is suitable for voltage amplification in the low frequency ranges. It can be used for special applications in Industry, Nuclear Physics Laboratories, neuro- and myo-graphic investigations and similar purposes.

Frequency response: 5c/s—5kc/s (gain 10^4 and 10^5) 25c/s—3kc/s (gain 10^6).
Gain: 10^6 Max. Switched and variable controls provide continuous variation.
Input: balanced or unbalanced, impedance 20MΩ (grid-grid).
Output: balanced or unbalanced.
Output voltage: 400V pk-pk max.
Calibration signal: 0.1 mV, 1mV or 10mV.

Write for the latest Cossor catalogue or ask for a representative to call and discuss your special requirements.

COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

COSSOR HOUSE, P.O. BOX 64, HIGHBURY GROVE, LONDON, N.5.
Telephone: CANonbury 1234 (33 lines) Telegrams: Cossor, Norphone, London Cables: Cossor, London Codes: Bentley's Second TAS/CI.17

New oscillograph 1059

ADVANCED
*TRUE
DOUBLE-BEAM
OSCILLOGRAPH

**True double-beam—i.e. both beams use a common x-axis and there is no beam switching.*

CATHODE-RAY TUBE
Cossor 4 in. (10 cm.) double-beam, p.d.a., type 93D with green fluorescence, operating with overall accelerating potential of 3 kV or 6 kV.

Y1 AMPLIFIER
1 c/s to 10 Mc/s (30% down).
Rise-time: 0.04 μsec.
Output deflection: 6 cm (4 cm at 10 Mc/s).
Sensitivity: calibrated 100 mV/cm to 10 V/cm.
Sensitivity control: in steps 3:1 and 10:1 with continuously variable intermediate control.
Input Attenuator impedance: 1.2 MΩ and 65 pF.

Y2 AMPLIFIER
Identical with Y1 amplifier.

SIGNAL DELAY
200 mμsec approximately. Not more than 10 mμsec differential between channels.

PRE-AMPLIFIER (2)
Gain 10. 5 c/s to 200 kc/s (30% down).
Input Resistance: 3 MΩ.
One for A1 amplifier, the other for A2 or X amplifier.

PROBES (OPTIONAL EXTRA)
Frequency-compensated "L" attenuator.
Input impedance: 6 MΩ and 15 pF.
Insertion loss: 10:1.

TIME-BASE
Triggered.
Range: 0.03 μsec/cm to 15 msec/cm in eleven steps. Triggered from positive or negative signals derived externally or from Y1 amplifier.
Sensitivity: pulse—1 cm. deflection or 2 V external. Sine wave—2 cm deflection or 2 V r.m.s. external at frequencies up to 5 Mc/s.
Expansion amplifier, continuously variable gain up to 5 times. Time-base output available at front panel on slow speed ranges.
Delayed time-base: continuously variable delay 2 μsec to 150 μsec. Delay jitter not greater than 1 part in 1,000. Sensitivity pulse —1 cm deflection or 2 V external.

X AMPLIFIER
10 c/s to 750 kc/s (30% down).
As time-base amplifier: continuously variable expansion up to 5 times.
As independent X amplifier: sensitivity variable from 1 V/cm to 100 V/cm in 5 ranges.

CALIBRATION
Voltage measurement: internal calibrating voltage (square wave) referred through sensitivity control of the amplifiers. Accuracy ±3%.
Time measurement: by directly calibrated X shift control (±5%) and/or by 20 mμsec (±3%) black-out pips (for accurate measurement of rise-time).

POWER SUPPLY
Mains: 100 V to 130 V and 200 V to 250 V.
Frequency: 50 c/s to 100 c/s.
Consumption: 550 W.
Internal supplies are stabilized where necessary.

SIZE AND WEIGHT

Height:	17½ in.	(43.2 cm).
Width:	12 in.	(30.5 cm).
Depth:	24¾ in.	(62.9 cm).
Weight:	80 lb.	(36.3 kg).

ACCESSORY
Camera Model 1428.

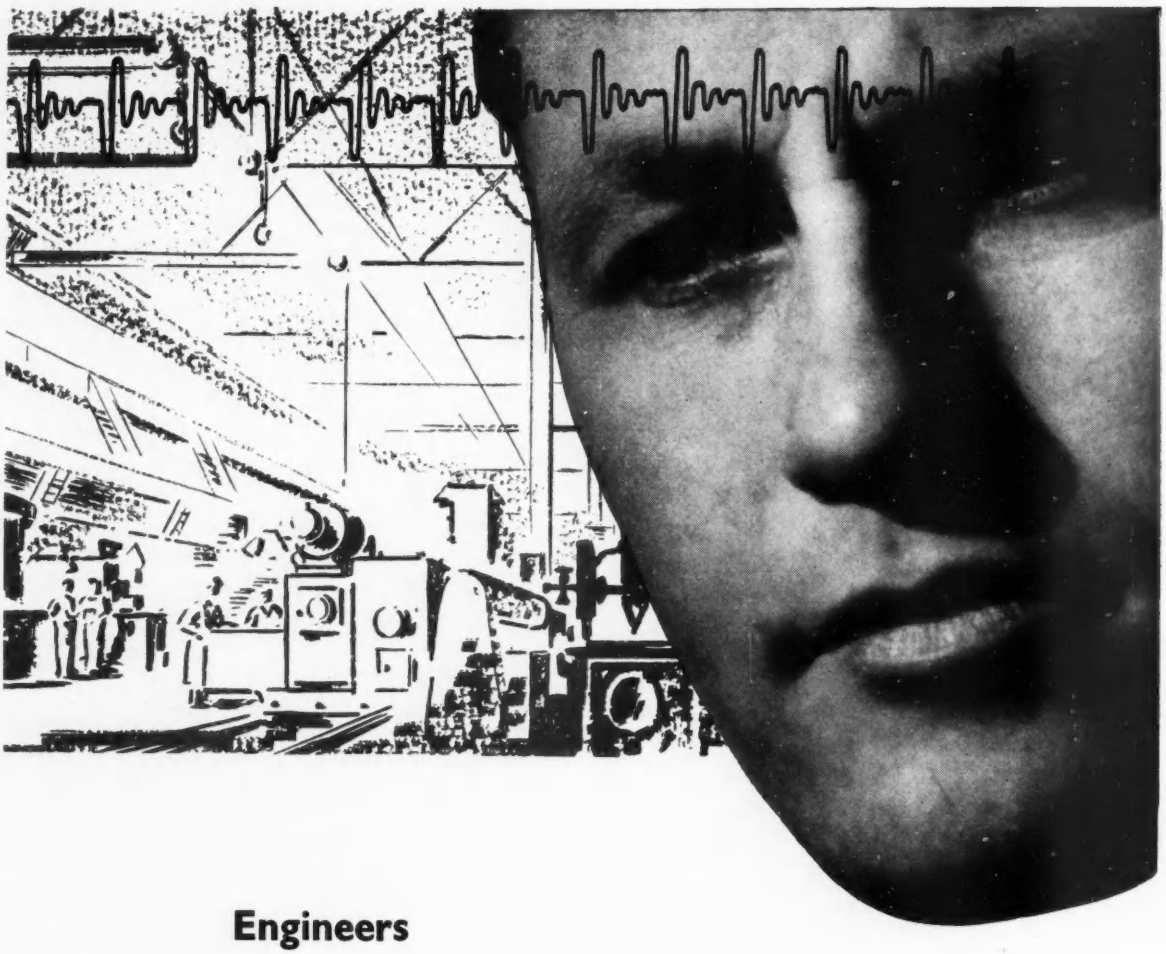
COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

COSSOR HOUSE, P.O. BOX 64, HIGHBURY GROVE, LONDON, N.5.

Telephone: CANonbury 1234 (33 lines). Telegrams: Cossor, Norphone, London. Cables: Cossor, London. Code: Bentley's Second. TAS/CI.11

EE 8038 *for further details*



Engineers

with

vibration

problems

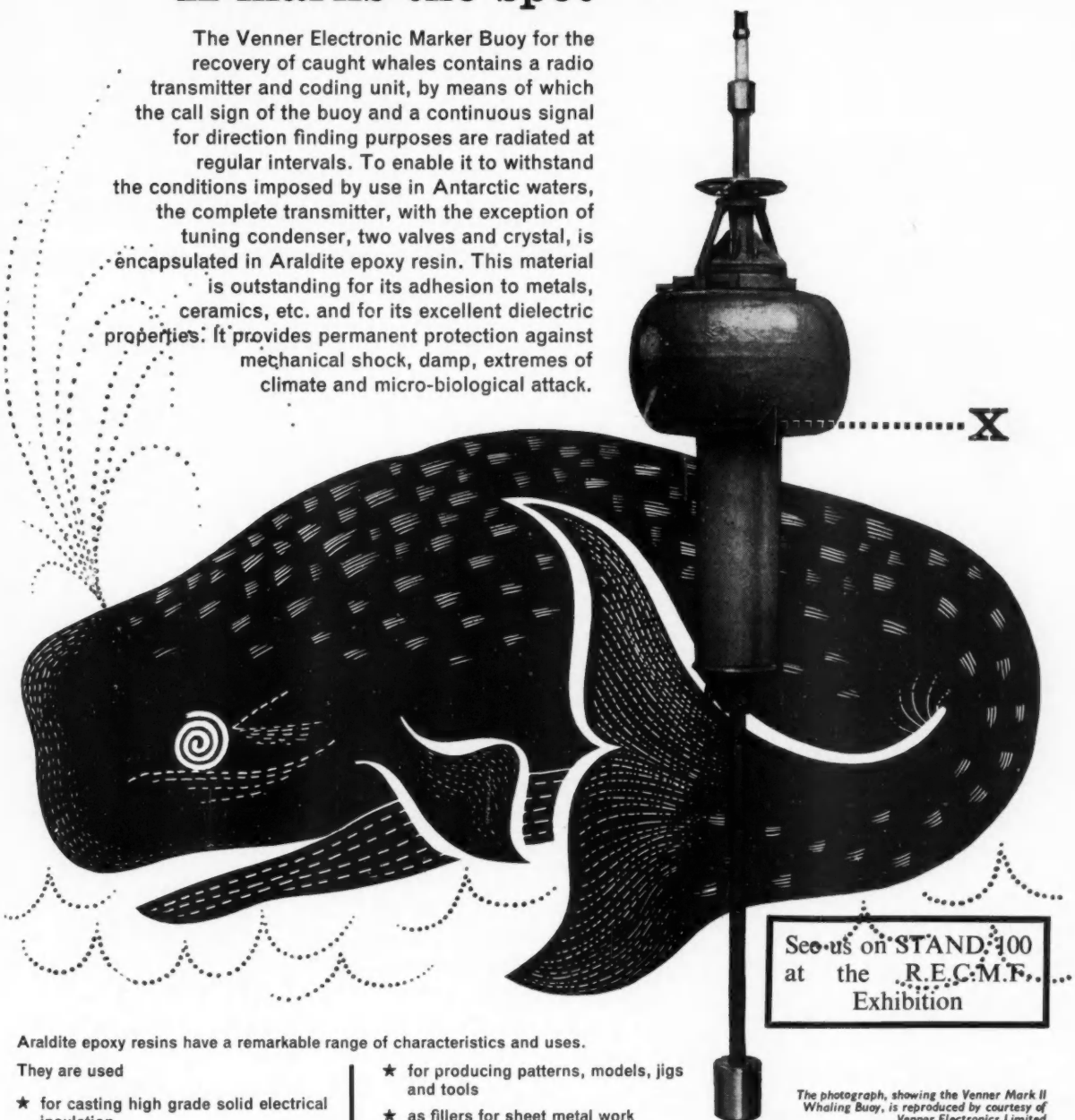
consult . . . . . SILENTBLOC

Manufacturers of
Anti-vibration mountings
Flexible Couplings and Bearings

SILENTBLOC LIMITED MANOR ROYAL CRAWLEY SUSSEX
Telephone : Crawley 2100
Telegrams : Silentbloc Crawley

X marks the spot

The Venner Electronic Marker Buoy for the recovery of caught whales contains a radio transmitter and coding unit, by means of which the call sign of the buoy and a continuous signal for direction finding purposes are radiated at regular intervals. To enable it to withstand the conditions imposed by use in Antarctic waters, the complete transmitter, with the exception of tuning condenser, two valves and crystal, is encapsulated in Araldite epoxy resin. This material is outstanding for its adhesion to metals, ceramics, etc. and for its excellent dielectric properties. It provides permanent protection against mechanical shock, damp, extremes of climate and micro-biological attack.



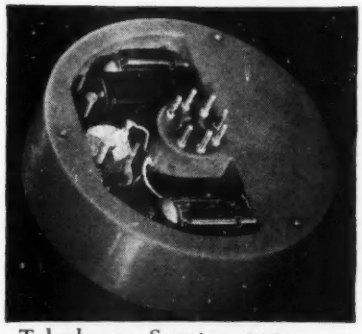
See us on STAND 100 at the R.E.C.M.F. Exhibition

The photograph, showing the Venner Mark II Whaling Buoy, is reproduced by courtesy of Venner Electronics Limited

Araldite epoxy resins have a remarkable range of characteristics and uses.

They are used

- ★ for casting high grade solid electrical insulation
- ★ for impregnating, potting or sealing electrical windings and components
- ★ for producing glass fibre laminates
- ★ for producing patterns, models, jigs and tools
- ★ as fillers for sheet metal work
- ★ as protective coatings for metals, wood and ceramic surfaces
- ★ for bonding metals, porcelain, ceramics, etc.



may we send you full descriptive literature

Araldite *epoxy resins*

Araldite is a registered trade name

CIBA (A.R.L.) LIMITED Duxford, Cambridge. Telephone: Sawston 2121

AP.372

EE 8042 *for further details*

WORLD'S MOST ADVANCED

INSTRUMENTATION

TAPE RECORDER

FOR LABORATORY *AND* FIELD APPLICATIONS

SO VERSATILE THAT A SINGLE MACHINE WILL SERVE AS LABORATORY RECORDER, AIRBORNE RECORDER OR TAPE LOOPER.

GREATEST PRECISION — GREATEST PERFORMANCE

B & K–Simplex

GREATEST DEPENDABILITY — GREATEST VERSATILITY

ACCURACY EQUAL TO OR BETTER THAN MORE EXPENSIVE STEAM RECORDERS OF TEN TIMES THE SIZE AND WEIGHT.

***See this recorder at the* FIFTH INTERNATIONAL INSTRUMENT SHOW**

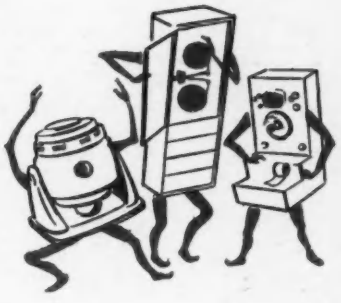
April 6 — 10th

U.K. LICENSEES

B & K LABORATORIES LTD.
4 TILNEY STREET, PARK LANE, LONDON, W.1.

If **U R**
interested in
B & K
world famous
Instrumentation—

PTO



Postage will be paid by licensee

No postage stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. S.E. 1312

B. & K. LABORATORIES LTD.,
4 Tilney Street,
Park Lane,
London, W.1.

For many years, B & K Laboratories have been privileged to supply leading U.K. concerns with special instrumentation, particularly from abroad.

An international approach to electronic applications is resulting in many new and improved methods of measurement for all kinds of design and production, and to facilitate this trend B & K issue periodic bulletins describing modern measurement devices having regard to the needs of British users.

If you would like to have this information, please fill in the card below.

Please send your technical information to me as follows:

Name ..... Position .....
BLOCK CAPITALS PLEASE

Firm .....

Address .....

My particular field of interest is as follows:

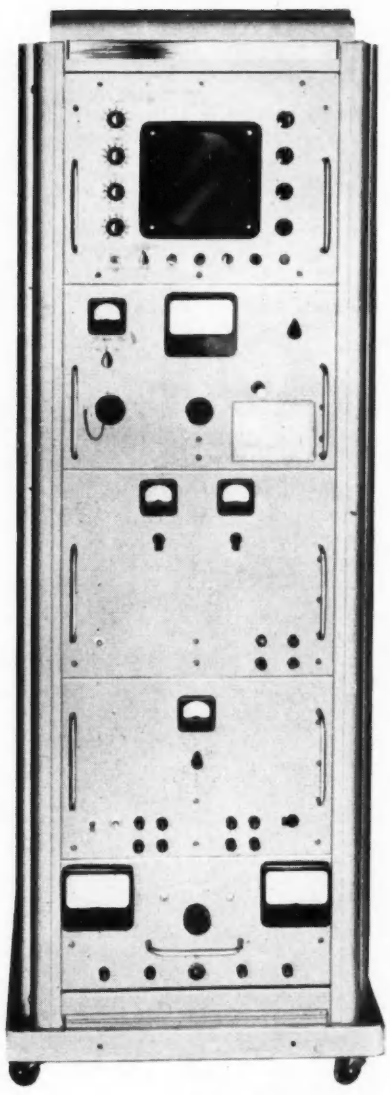
☐ General Instrumentation (A) ☐ Vibration (B) ☐ Acoustics (C)
☐ Microwave (D) ☐ Computers etc. (E) ☐ Tape recording (F)
☐ New electronic components (G) ☐ Nuclear and chemical (H)

☐ Please send Tickets for the next International Instrument Show

My associate Mr. .....of the above address, would also like to receive this information.

LOOK AHEAD — WITH POLARAD

PROVEN RELIABILITY



MODEL DA-70

FIRST SPECTRUM ANALYSER OF ITS KIND — EXTENDS POLARAD COVERAGE TO 50,000 — 100,000 MC/S

SEE OUR PRODUCTS
AT THE
FIFTH INTERNATIONAL INSTRUMENT SHOW

- ★ Dispersion continuously adjustable from 50 to 500 mc/s.
- ★ High I.F. assures image rejection and prevents video detection.
- ★ Frequency calibration with wavemeter to 0.2%
- ★ Wide resolution and dispersion allows viewing narrow pulses.
- ★ Frequency marker for measuring frequency difference.
- ★ Single tuning control, no klystron modes to set.
- ★ 7-inch CRT display.

FOR FURTHER INFORMATION PLEASE CONTACT

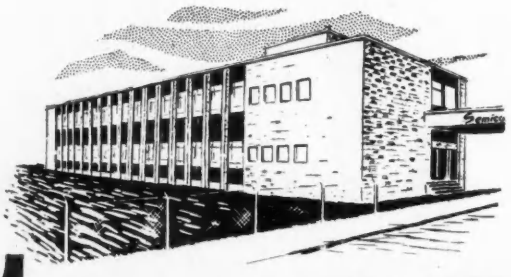
B & K LABORATORIES LIMITED
4 TILNEY STREET, PARK LANE, W.1. TEL : GRO 4567

EE 8044 *for further details*

Semiconductors Limited

Applications Laboratory

making new equipment possible—existing equipment better . . .



The Semiconductors Limited Transistor Applications Laboratory, with greatly improved facilities, is now installed in a new building adjacent to the Swindon factory. This will considerably increase its capacity to assist manufacturers in the correct selection and use of Semiconductors transistors. You are invited to take advantage of this service, either directly or through your Semiconductors representative.

In addition to providing direct assistance to manufacturers, the Applications Laboratory is continuously investigating new approaches to existing problems.

For immediate assistance on your transistor problems telephone the Applications Laboratory SWINDON 6421.

transistors

The evaluation of transistor high-frequency parameters is a continuing study in this specially-equipped section of the Transistor Applications Laboratory.

Semiconductors Limited

CHENEY MANOR · SWINDON · WILTSHIRE

Telephone: Swindon 6421/4 Telegrams: Semicon, Swindon

** NEW APPLICATION NOTES AND DATA SHEETS ARE CONSTANTLY BEING ISSUED*
ARE YOU ON THE MAILING LIST?

SC.12

EE 8045 *for further details*

precision built

See us at
the RECMF
Grosvenor House

W. 7001 FEED-THROUGHS

THE FIRST OF A
group of insulated feed-throughs,
this item is in alkyd (of course)
which gives it considerably higher insulation
without any increase in size.
Low priced and quickly fitted
available **NOW.**

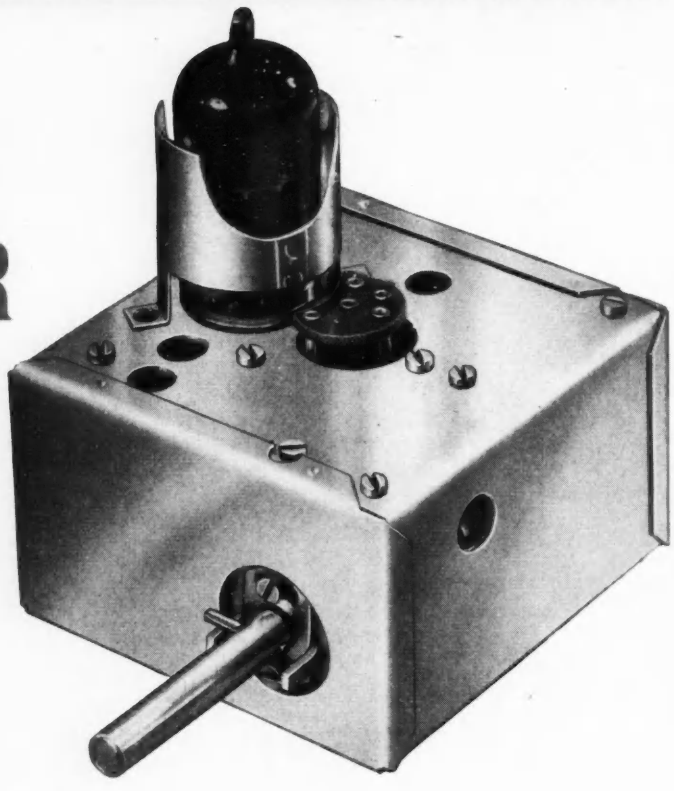
HARWIN *ENGINEERS LTD*

RODNEY ROAD · PORTSMOUTH · HANTS · Telephone : PORTSMOUTH 35555

EE 8046 *for further details*

Cyldon COMPONENTS

NEW
PRINTED CIRCUIT
F. M. TUNER



The Cyldon Printed Circuit F.M. Tuner, with its unique design and construction, offers the optimum performance obtainable with a double triode valve.

Using a double triode valve with one section as the R.F. amplifier and the other as a self-oscillating mixer, this tuner has the following design features:-

1. Supplied complete, pre-aligned and ready for installation in the receiver.
2. Series or parallel heater chain.
3. 10.7 Mc/s I.F. (oscillator low).
4. High gain which is constant over the entire F.M. Band.
5. Radiation within B.R.E.M.A. limits.
6. Absolute stability.
7. Plug and socket power connections.
8. Aerial input 80 ohm. unbalanced.
9. 3-point base mounting for mechanical resilience.
10. 180° rotation of spindle for full frequency range, providing direct mechanical coupling to the gang of AM/FM receivers.

At present available only for the U.K. F.M. Band

SYDNEY S. BIRD & SONS, LTD. POOLE · DORSET

Enquiries and sales correspondence:
SALES & TECHNICAL LIAISON OFFICE, 3 PALACE MANSIONS, PALACE GARDENS, ENFIELD, MIDDLESEX
Telephone: Enfield 8371-2-3 Telegrams: "Cyldon, Enfield"

If CHASSIS are your interest then LEKTROKIT is the complete answer

THIS VERSATILE ELECTRONIC CONSTRUCTION KIT

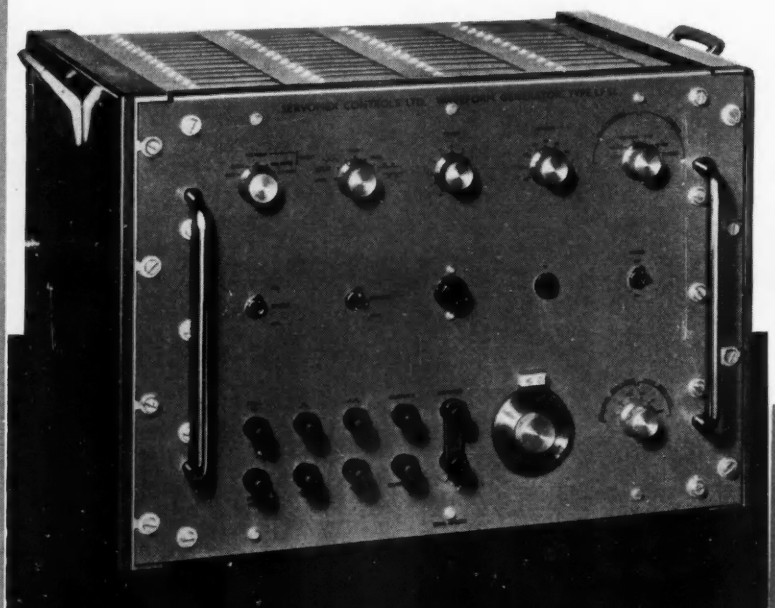
GIVES YOU THE FOLLOWING ADVANTAGES

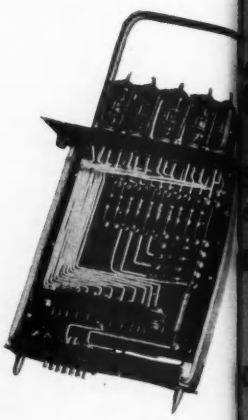
- ★ No delay in getting your ideas put into practice.
- ★ No need to interrupt your smooth flow of quantity production to produce Experimental Chassis.
- ★ Lektrokit Experimental Chassis can be modified quickly and simply.
- ★ A wide range of accessories permit the construction of bench or rack mounted units for permanent use.
- ★ Units can be fitted together almost indefinitely in a variety of ways.

A·P·T ELECTRONIC INDUSTRIES LIMITED

CHERTSEY ROAD
BYFLEET · SURREY
PHONE: BYFLEET 4411-2-3-4
GRAMS: APTRAN · BYFLEET

the most flexible supply of test signals for testing servo mechanisms





This unique instrument is being used by discriminating control engineers all over the world for measuring the dynamic response of automatic control systems.

With it, one can carry out measurements of the frequency response to sinusoidal input; the step-function response; the response to ramp functions; the response to sine-squared pulses; and many other special tests.

- ★ *Sine waves from 500 cycles/sec. down to one cycle every 2,000 secs. (33 minutes).*
- ★ *Pulses and square waves with rise time less than 10 microseconds.*
- ★ *Ramp functions with a linear rise variable from 1 millisecond to 1,000 seconds.*
- ★ *Over 30 different waveforms available.*
- ★ *Voltage variable between 100 microvolts and 150 volts peak-peak.*
- ★ *Load current up to 5 milliamps peak.*

1. Selector switch at "CONTINUOUS"
2. Selector switch at "SINGLE" - a step with continuously variable slope
3. Selector switch at "DOUBLE" - a single isolated pulse in TEN different forms

THE PROBLEM...

To measure the frequency response of a massive servo control with cut off frequency around one cycle in five minutes, and with an output amplitude of ±20°.

a possible solution,

Set up a conventional sinewave generator running at a frequency substantially lower than the expected cut off, and adjust the amplitude to give peaks of ±20° at the servo output.

DIFFICULTY 1: *Assuming that a suitable generator exists, each change of amplitude will require about an hour to allow the system to settle and take a reading at the next peak. Thus, proceeding this way, several hours will be wasted before tests can start.*

DIFFICULTY 2: *If it is required to make transient tests, the experimental arrangement will have to be upset and new equipment brought up.*

the Servomex solution,

Use the LF.51 set to SINGLE SHOT and SQUARE WAVE. Turn the amplitude up to give exactly 20° displacement of the servo output. Switch to CONTINUOUS and SINE WAVE and start making measurements. Total time wasted: less than ten minutes. Furthermore, transient tests using virtually any wave form you may require can be carried out at the flick of a switch and without any further delay.

This "problem" stresses two practical advantages of the LF.51 — the single shot facility for setting the amplitude, and the fact that the upper and lower limits of the output voltage are identical whatever wave form is used. These are practical advantages arising from the fact that the LF.51 was designed by servo engineers. There are many other practical advantages of the instrument which will appeal to you if you are a servo engineer, or otherwise engaged on measuring the dynamic response of low frequency systems, and if you would like a demonstration and test under practical working conditions, *you are invited to write or telephone for an appointment.*

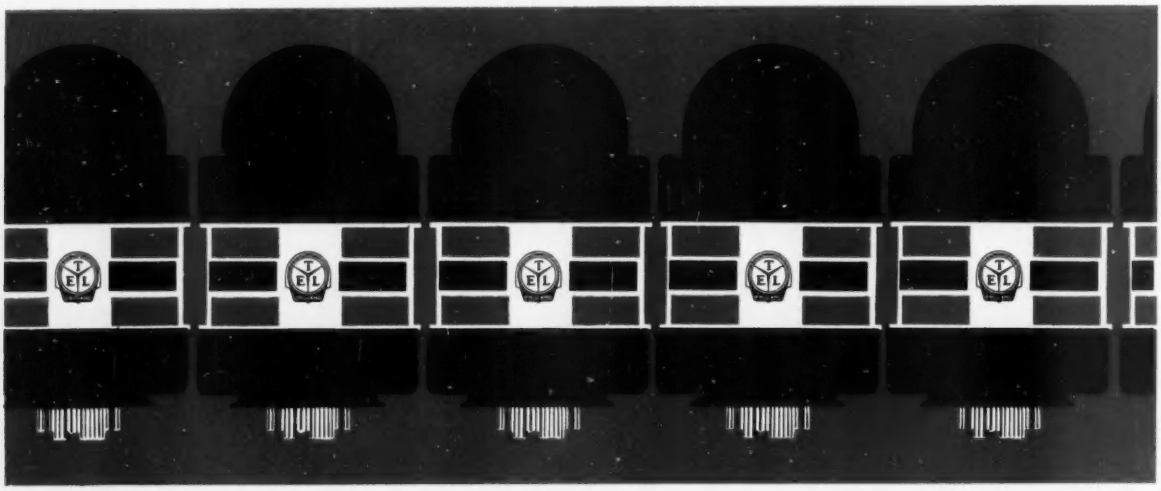
SERVOMEX

CROWBOROUGH, SUSSEX. PHONE CROWBOROUGH 1247

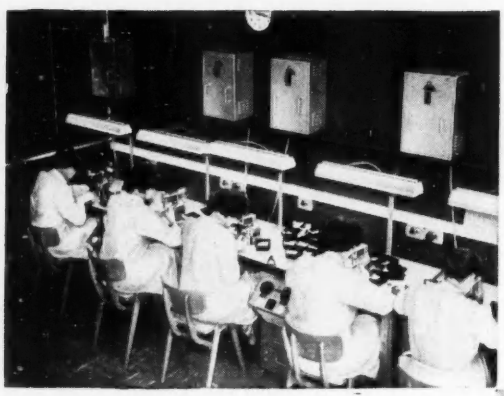
low frequency wave form generator

the World's best!

FOR THE FIRST TIME IN BRITAIN



NOW IN QUANTITY PRODUCTION



The VS10G TROCHOTRON

1 MEGACYCLE BEAM SWITCHING TUBE

BRIEF SPECIFICATION:

Counting Speed		0 to 10^6 p.p.s.
Heater (Vh)		6.3V.
Min. Spade Resistor (R_s min.)	$V_s = 100V$	75kΩ
Max. Spade Resistor (R_s max.)	$V_s = 100V$	130kΩ
Min. Input Pulse Duration ...		·66μS
Input Pulse Amplitude ...		55V.
Base		B26A*

For full details write to:
The Technical Services Department,

ERICSSON

TUBE DIVISION

BEESTON · NOTTINGHAM · ENGLAND

ERICSSON TELEPHONES LIMITED, HEAD OFFICE, 22 LINCOLN'S INN FIELDS, LONDON, W.C.2.

Telephone: HOLborn 6936

E81A-103A

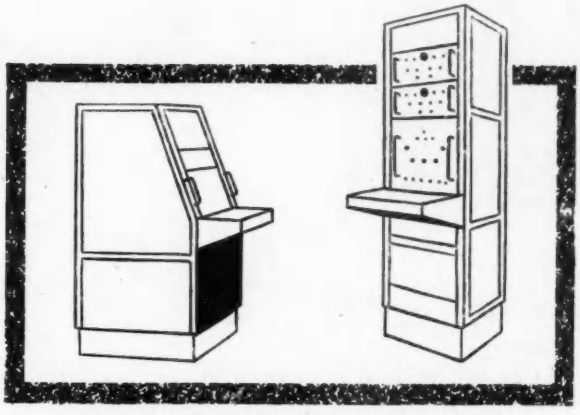
What the well-dressed electronic brain is wearing!

Nowadays you'll find that more and more electronic apparatus is being clothed in the smart efficiency of Hassett & Harper cabinets. Tailor-made to individual requirements or 'off the peg' in a wonderful range of component—flattering designs!

Discerning electronic brains, fashion-conscious computers, in fact electronic equipment of all kinds, look better—are more easily operated in Hassett & Harper racks and cabinets.

Why not ask us for more details?

Appearances count even in electronics. "If it looks right, it *is* right", they say—and that's certainly true in our case.

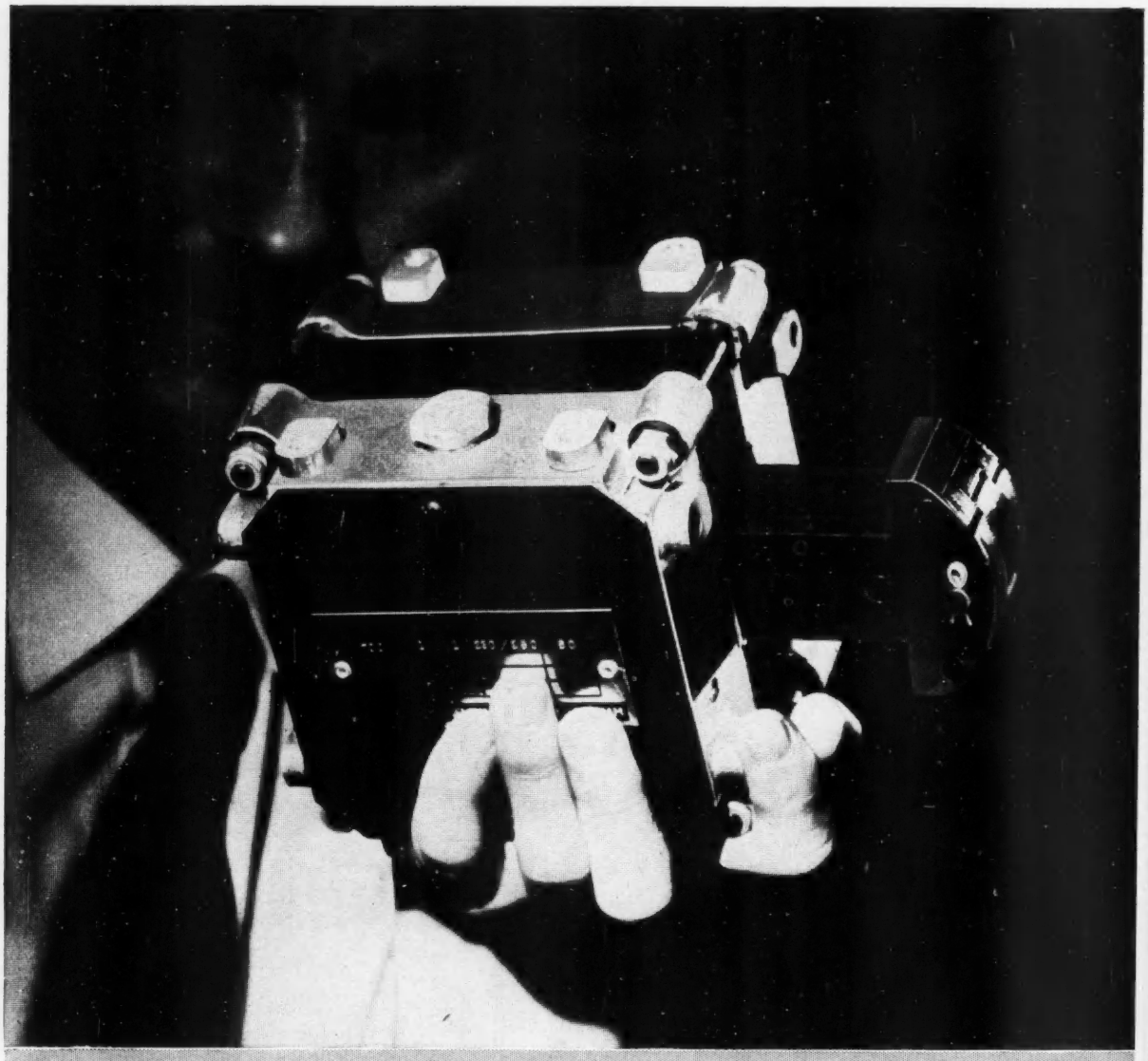


SEE OUR EXHIBIT AT THE R.E.C.M.F. EXHIBITION, STAND NO. 147

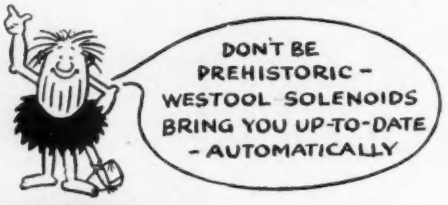
Hassett & Harper Ltd

REGENT PLACE · BIRMINGHAM 1 · TEL: CENTRAL 6418

LONDON SHOWROOM: 1 GREAT CUMBERLAND PLACE, LONDON W.1. TELEPHONE: PADDINGTON 4691



WESTOOL SOLENOIDS



Westool Solenoids are 'naturals' wherever automatic control is required. Being electrically operated, they can be incorporated easily into any control system whether fully automatic or push-button; being compact they lend themselves to the streamlined machine layout of today. Their action is instantaneous and certain.

Westool make a wide standard of A.C. and D.C. Solenoids to cover most industrial requirements, and some of these are illustrated here. Practical design, use of the best materials, care in manufacture and thorough testing ensures that Westool Solenoids are the best you can obtain.

For technical data sheets and price list write or telephone today.

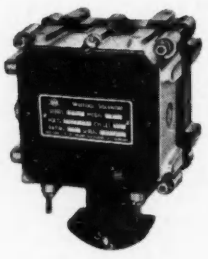
WESTOOL LIMITED

ST. HELEN'S AUCKLAND, CO. DURHAM

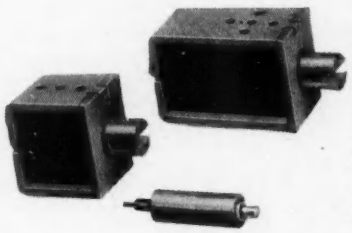
Phone: West Auckland 551/5 **Grams: Solenoid, West Auckland**

Birmingham Office:
7 Newhall St., Birmingham 3
Telephone: Central 3901

T:B 113

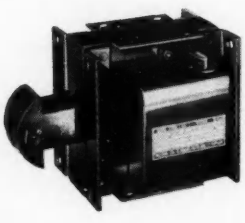


Series 700 A.C.

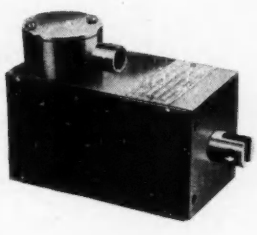


Miniature Solenoids A.C. & D.C. from 225 cm. grammes to 1.5 ozs.

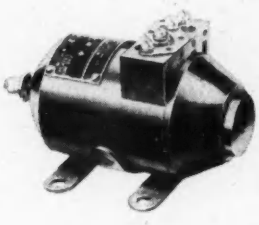
Series 'C', D.C.



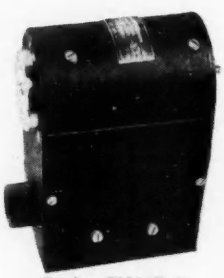
Series 600 A.C.



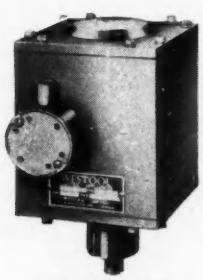
Series 'DK', D.C.



Series 1174 D.C.



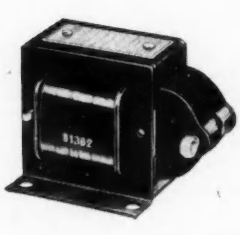
Series 2030 D.C. with rectifier



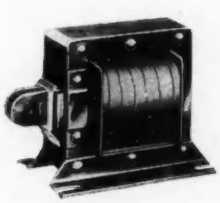
Series 'E', D.C.

Series 'L', D.C.

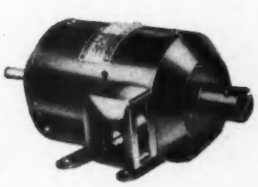
. . . better designed, better made



Series 500 A.C.

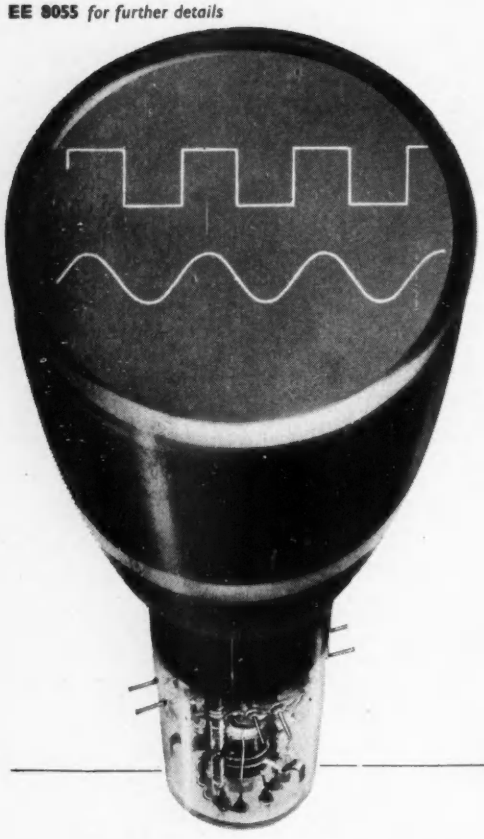


Series 400 A.C.



Series 2030 D.C.

EE 8055 *for further details*



4LP1
the only P.D.A. tube with TWO traces from ONE gun

The new 'Etel' four-inch instrument tube 4LP1 is the most economical high performance tube for dual trace oscillography.

Two traces are provided in the simplest and most economical manner—by means of a single gun with a beam dividing electrode. Sensitivity of 27 V/cm at 3kV is attained by employing a post deflection accelerator.

The 4LP1 is recommended for high quality general purpose applications. It has a flat face and side connections to the deflector plates. Write for full information to the address below.

ABRIDGED DATA

4LP1 single gun dual trace tube.

SCREEN TYPE	P1
DEFLECTION	electrostatic
POST DEFLECTION ACCELERATOR	single stage
SCREEN DIAMETER	4 inches
MAXIMUM OVERALL LENGTH	15¼ inches

Capacitances

$c_{x'-x''}$	1.4 to 2.0 pF
$c_{x'}$—all (x'' earthed)	2.7 to 3.8 pF
$c_{x''}$—all (x' earthed)	2.7 to 3.8 pF
$c_{y'}$—all	2.5 to 3.8 pF
$c_{y''}$—all	2.5 to 3.8 pF
$c_{y'-y''}$	<0.1 pF

Typical Operating Conditions

V_{a1}	1.5 kV
V_{a2}	320 to 420 V
V_{a3}	1.5 kV
V_{a4}	3.0 kV
V_g (for cut-off)	−40 to −95V
Sx	27 V/cm
Sy′	27 V/cm
Sy″	27 V/cm

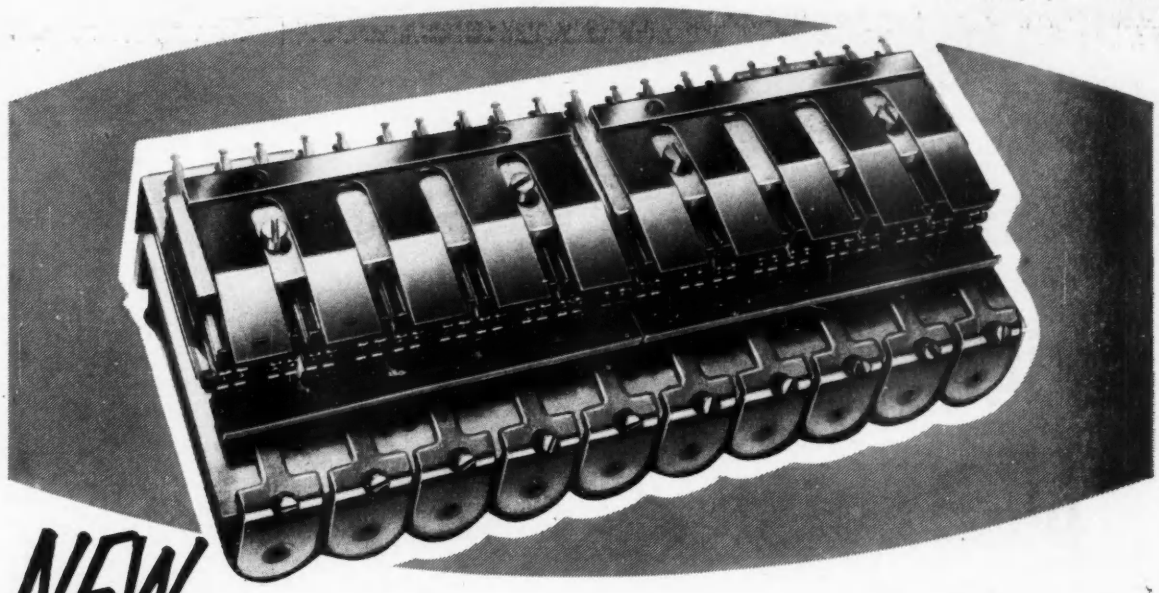
Beam intermodulation is largely eliminated by the very low $c_{y'-y''}$ capacity.

ETEL
REGD. TRADE MARK

CATHODE RAY TUBES

ELECTRONIC TUBES LIMITED · KINGSMEAD WORKS · HIGH WYCOMBE · BUCKS · TEL: HIGH WYCOMBE 2020
ETL REV 11A

EE 8056 *for further details*



NEW

TMC TEN-WAY MULTIPLE RELAY

HALVES THE COST OF RELAY SWITCHING

- Two-screw fixing
- No separate mounting plate required
- Alkyd resin moulded contact stack
- Machine adjusted spring leaves virtually eliminate the need for re-adjustment
- Twinned crossed-radii silver contacts
- Card-operated spring sets
- Contact actions available: 4C+2M max. rated at 300 mA at 60V max. suitably quenched

STAND No. 21
R.E.C.M.F.
EXHIBITION
GROSVENOR HOUSE
6th-9th APRIL

Also on display

1. The Type 521 Carpenter Polarized Relay replacing Types 5 and 51 to give increased performance at reduced costs.
2. The first double change-over Carpenter Polarized Relay—Type 412 employing a moulded mica-glass frame for high stability.

TELEPHONE MANUFACTURING COMPANY LIMITED

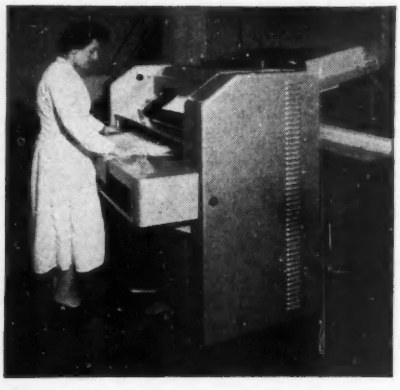
Relay Division,
Hollingsworth Works, London SE21
Telephone: GIPsy Hill 2211

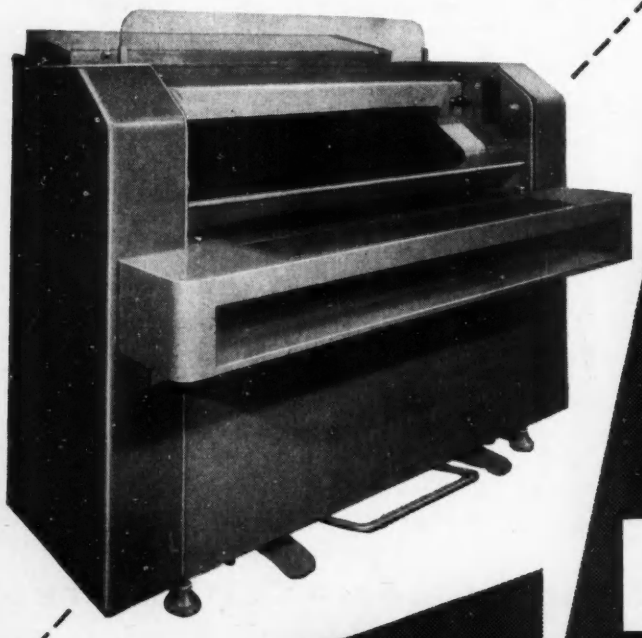
Engineering, Marine, Welding & Nuclear Energy Exhibition
April 16th to 30th
Stand No. 5 BB, Empire Hall.

Rapid, high-quality photoprinting

and no ventilating system required

The Ilford AZOFLEX Model 246 Combine printing and developing machine (formerly known as Model 46/35) is designed for use in the print room of the large drawing office. It does not produce unpleasant fumes and special ventilating systems are thus unnecessary, making it a simple matter to move the machine to a new position at any time.





- Exposure, development and print delivery synchronized for simplicity of operation.
- All controls conveniently located for rapid, effortless adjustment.
- Pneumatic-assisted handling of originals and sensitised material to obviate fatigue.
- Complete design co-ordinated for exceptionally high potential output.
- Excellent mechanical layout giving silent, vibrationless running.
- Comprehensive maintenance service available at nominal cost.

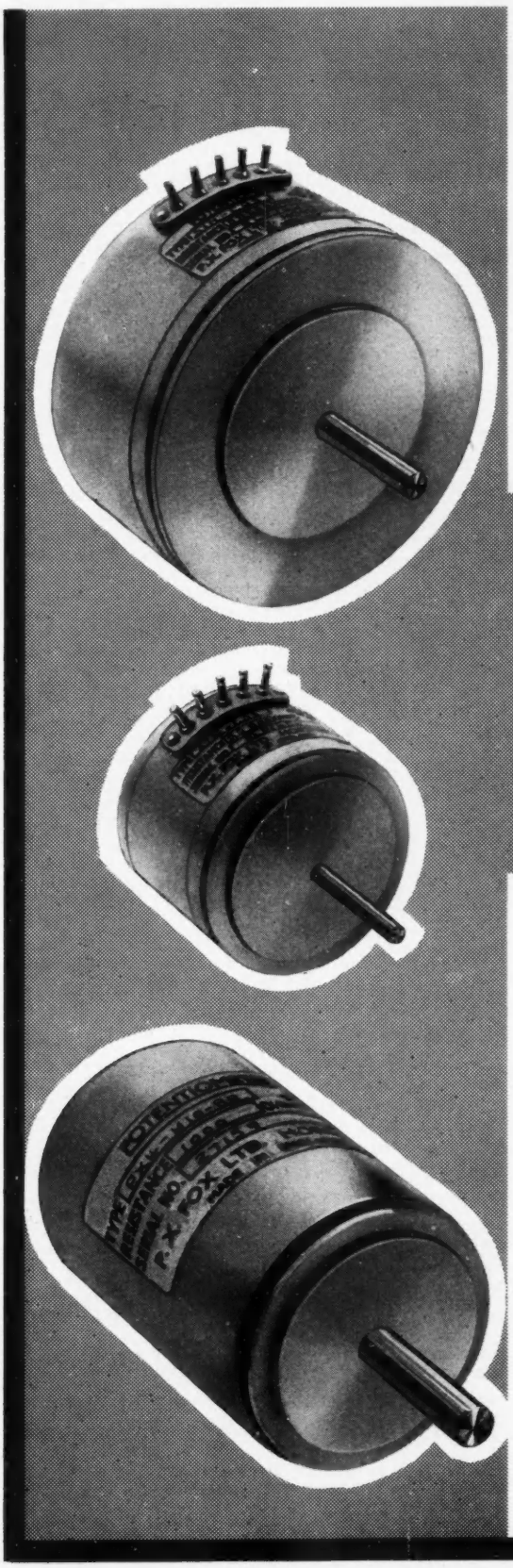
Capacity: rolls and cut sheets up to 42 in. wide.
Printing speed: from 2 ft. to 30 ft. per minute.
Lamp: H.P.M.V. quartz, 3,000 watt.
Dimensions: height, 58 in., width, 72 in., depth (tray extended) 80 in. Weight : approx. 1,400 lb.

Subject to certain conditions, the majority of AZOFLEX photoprinting machines can be hired as an alternative to outright purchase.

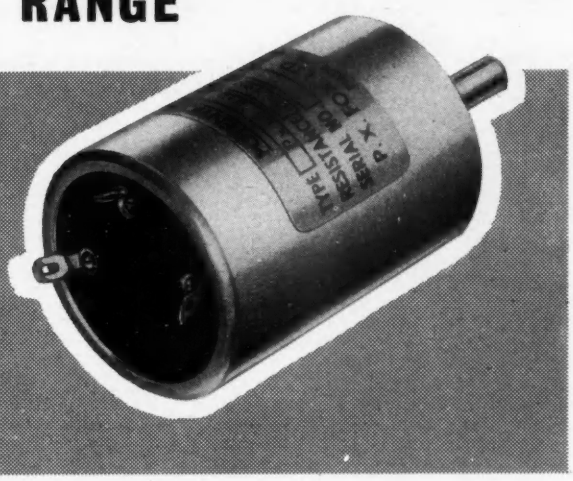
ILFORD *Azoflex*

PHOTOPRINTING MACHINES & MATERIALS

Full details from
ILFORD LIMITED, INDUSTRIAL SALES DEPT. AZ18G
ILFORD, ESSEX. TELEPHONE: ILFord 3000



NEW ADDITIONS TO THE FOX POT RANGE



S.B. and S.G. with sin.-cos. Can be ganged up to three linear sections. Helical servo mounting with ball races. New helical totally enclosed, fully tropical if required.

To give prompt and personal service, we have opened a London office at 104 Chislehurst Road, Orpington, Kent. Telephone Orpington 21031.

P. X. FOX & CO. LTD

Hawksworth Road, Hosforth, Yorks.

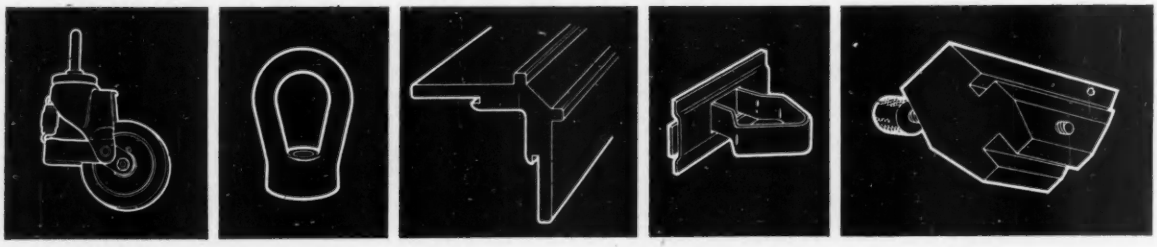
'Phone : Horsforth 2831/2

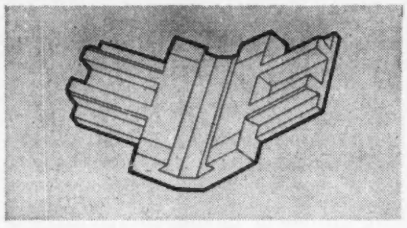
POTENTIOMETRY **BY FOX**

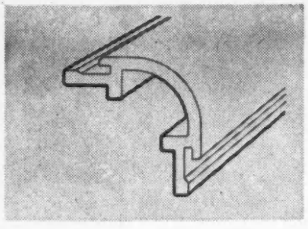
EE 8059 *for further details*

62 big Imlok developments

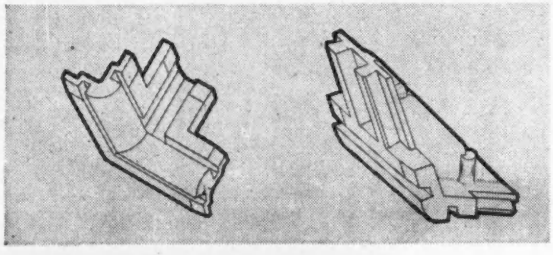
TO SAVE YOU MONEY ON CASE CONSTRUCTION!

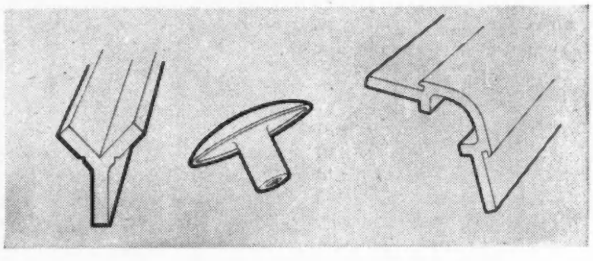






IMLOK—the unique cabinet construction system—now offers designers and engineers even more possibilities than before. Fifty-six new parts have been added to the already wide range of precision-made corner connectors, extrusions and accessories, and you can now buy Imlok in six different stages of manufacture. It means more versatility . . . more scope in case and cabinet design. The Imlok system is ideal for both prototype and production work





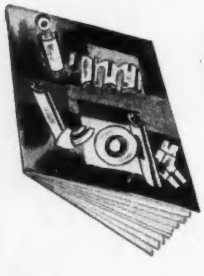
56 new parts

The addition of new connectors and extrusions means you can now have external or internal angles from 22½° to 90°. The new range also includes strengthening extrusions for extra heavy-duty structures, fashion trims, door pulls, castors, and many more. Full list on request

6 ways to buy

1. As individual connectors and with extrusions in 12ft. lengths. **2.** With connectors pre-drilled ready for assembly with self-tapping screws. **3.** With pre-drilled connectors and with extrusions custom-cut by Imhofs to your lengths and mitred. **4.** As a complete framework, ready for fitting with your own panels. **5.** As a complete structure with panels, but unpainted. **6.** As a complete structure, fully finished

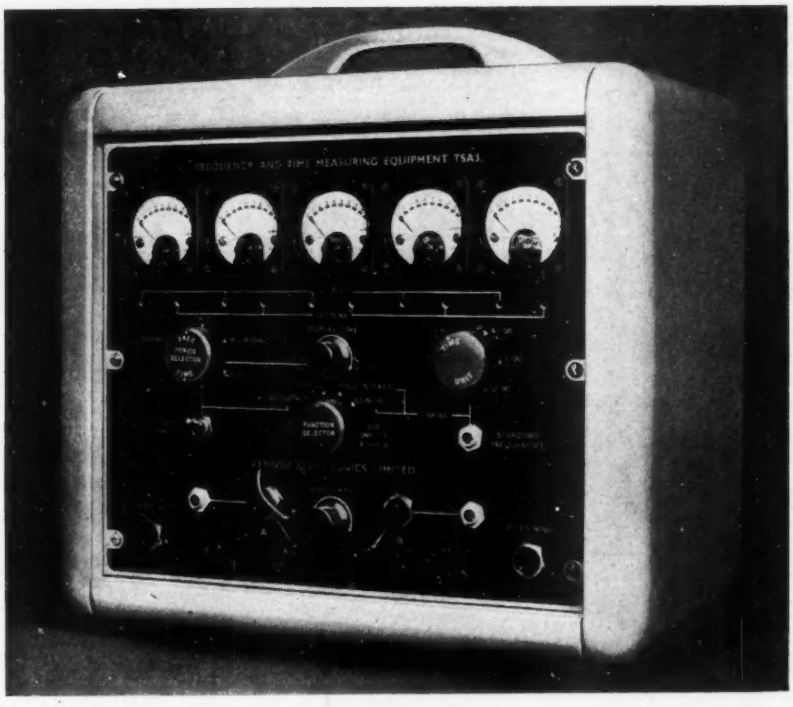
New 36-Page Imlok Manual
now available, includes illustrations and specifications of all Imlok parts, colour photographs of many cabinet and console designs built in Imlok, as well as new Imlok uses. Send now for free copy



IMLOK

Alfred Imhof Ltd., Dept. F4 Ashley Works, Cowley Mill Road, Uxbridge, Middx. Uxbridge 6231
Export & London Showrooms: 112-116 New Oxford St, WC1: Museum 7878

IMHOFS AGENTS OVERSEAS
AUSTRALIA Aladdin Industries (Pty) Ltd, Stanmore NSW
BELGIUM Rogelec, Ghent
CANADA Measurement Engineering Ltd, Arnprior
DENMARK Tage Schouboe, Copenhagen N
FINLAND Oy Scienta Ab, Helsinki
HOLLAND J.Th. van Reijsen, Delft
ITALY Prodel SPA, Milan
NEW ZEALAND Imarex Ltd, Auckland C3
NORWAY Birger Christensen, Oslo
SWEDEN Elektronlund AB, Malmo C
SWITZERLAND Walter Blum, Zurich 2/39
U.S.A. Bud Radio Inc, Cleveland 3, Ohio
BRIT. GUIANA British Caribbean Agencies Ltd, Georgetown, Demerara



REDUCED PRICES!

Due to the high rate of production achieved in 1958 the range of Venner Transistorized Equipment has been considerably reduced in price. The TSA 3, here illustrated is a typical example, representing a saving of £35.

Frequency and Time Measurement

The TSA3

Measures frequency up to 50 kc/s. or 100 kc/s.
Measures time from 0.1 mS to 11½ days.
More comprehensive at the price than any equivalent equipment.
Self checking on five frequencies.
Accuracy exceeds ± 0.005%.
Incorporates 106 transistors in 19 plug-in stages.
Digital Time base.
Variable display time from ½ sec. to 5 secs. or infinite.
Low power consumption.
Standard output frequencies at 0.1 c/s, 1 c/s, 10 c/s, 100 c/s, 1 kc/s, 10 kc/s.
0.1 second, 1 second and 10 second sampling times.
Size: 14½" × 7¾" × 11½"
PRICE: £240—50 kc/s model.
£245—100 kc/s model.

Transistor Stabilised Power Supply type TS 20.

This unit can be fitted inside the Frequency Meter to enable it to function from EITHER 200/250V, 50 c/s mains, or from 12V D.C. at the turn of a switch. Another important use for the unit is as a source of 8-12V D.C. (adjustable) at currents up to 300 mA, for use in laboratories, educational establishments, or for driving other transistorized equipment. Bench units are fitted with terminals. Size: 7¼" × 3¼" × 2½". **PRICE: £18** (fitted)

STAND 40
INTERNATIONAL TRANSISTOR EXHIBITION
EARLS COURT
MAY 21st–27th

VENNER

ELECTRONICS LIMITED

KINGSTON BY-PASS, NEW MALDEN, SURREY. *Tel:* **MALden 2442 (9 lines)**

A member of the Venner Group of Companies.

EE 8061 *for further details*

Miss Neasden says
she does not know
what a resistor is

Electrothermal

she should ask us...
we know quite a lot
about them

wire wound resistors
by

Electrothermal **STAND NO. 135**

R.E.C.M.F. Exhibition Grosvenor House W.1
April 6th to April 9th 1959

ELECTROTHERMAL ENGINEERING LTD 270 NEVILLE ROAD LONDON E.7

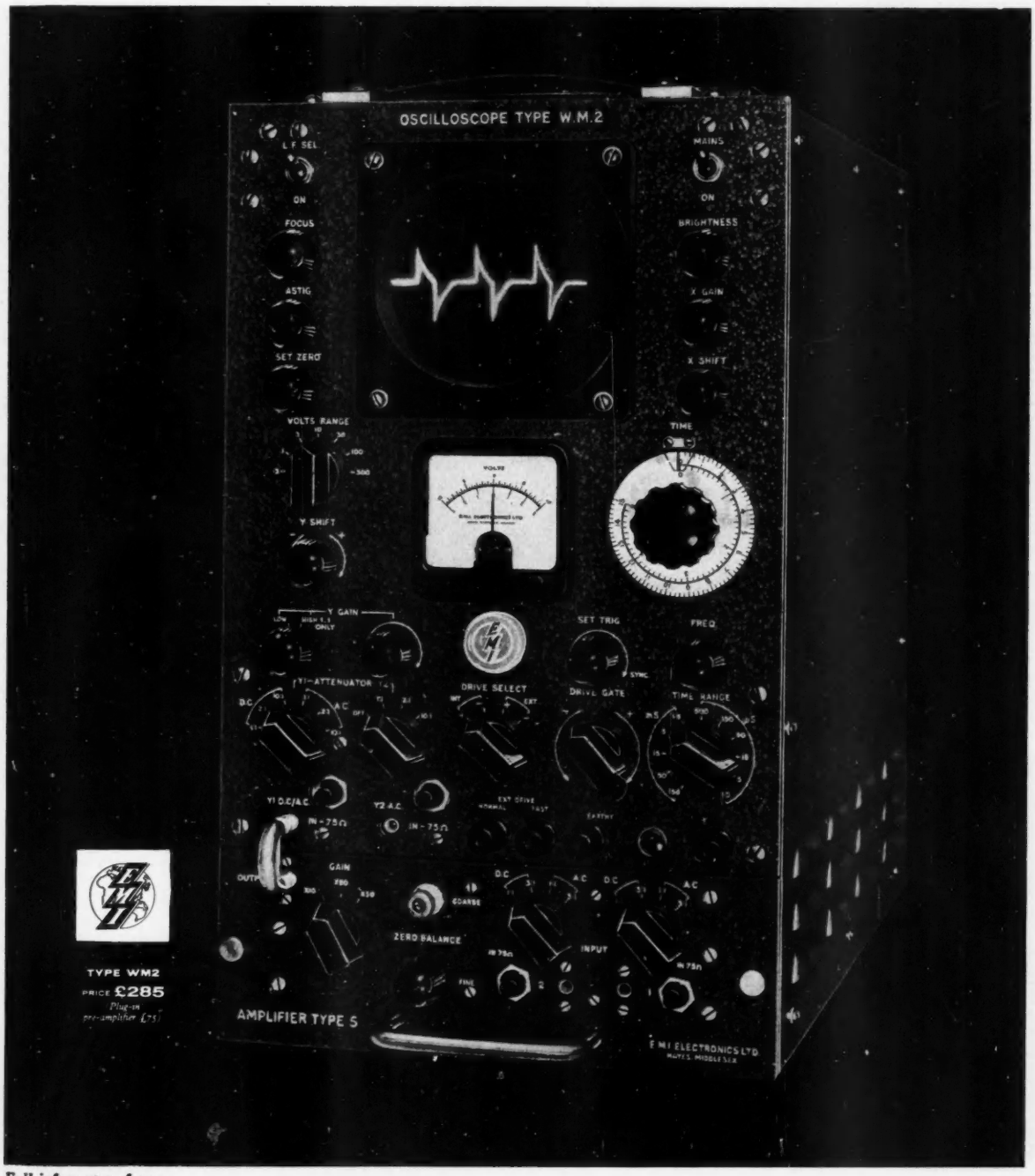
EE 8062 *for further details*

AT ITS PRICE WM2 HAS NO EQUAL FOR

BANDWIDTH AND SENSITIVITY

The WM2, complete with plug in pre-amplifier, is a versatile wide-band oscilloscope suitable for a large variety of applications. It is ideal for production testing, single shot photography and design and maintenance work on radar, television and computers.

* **Direct time and voltage measurement with 2% accuracy**
* **Built-in signal delay**
* **Bandwidth DC to 12 Mc/s**
* **Y sensitivity at full bandwidth 100 mV/cm**
* **Maximum Y sensitivity 3 mV/cm**
* **Maximum sweep speed 40 cm/μS**



Full information from:—

E.M.I. ELECTRONICS LTD (INSTRUMENT DIVISION) · HAYES · MIDDLESEX · TEL: SOUTHALL 2468

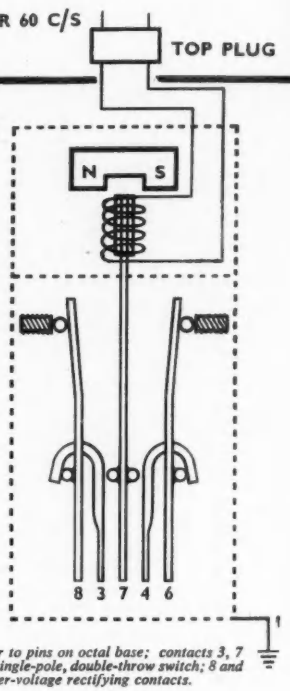
EE4

KENT SYNCHRONOUS CONVERTERS

for combined modulation and de-modulation

SPURIOUS E.M.F.'s < 1.0μV

LEAKAGE CURRENTS ≷ 10^{-11} Amp



Numbers refer to pins on octal base; contacts 3, 7 and 4 are the single-pole, double-throw switch; 8 and 6 are the higher-voltage rectifying contacts.

SPECIFICATION

CONTACT-SETTING (FOUR TYPES AVAILABLE)

SETTING	% of cycle during which	
	3 and 7 are in contact	4 and 7 are in contact
A	33.3	33.3
B	49.0	49.0
C	57.5	57.5
D	33.3	66.7

POWER SUPPLY AND COIL DATA

Normal working voltage: 6.3V r.m.s. (12V r.m.s. max.)
Frequency: 40, 50, 60c/s ±3c/s
Coil resistance: 115 ohms nominal
Coil inductive reactance at 50c/s: 37 ohms nominal
Normal current: 50 r.m.s. mA
Normal power consumption: 0.3 W

PHASING

The contact operation lags the applied voltage by 25° to 30°, 30° to 35°, and 35° to 40° with 40, 50 and 60 c/s supply frequency respectively.

RATING OF EACH CONTACT FOR d.c. NON-INDUCTIVE CIRCUITS

0.3V 100mA
3.0V 1mA
10.0V 0.1mA

Below 0.1V no electrical erosion occurs

SPURIOUS EFFECTS

Magnetically induced e.m.f.'s: less than 0.5 r.m.s. microvolts
Thermal e.m.f.'s: less than 1.0μV
Leakage currents: less than 10^{-11} amp
Contact bounce: negligible

PRINCIPAL DIMENSIONS

Height from chassis to top of plug: 4⅛ in. (105 mm) approx.
Can diameter: 1½ in. (38 mm) approx.
Base diameter: 1¾ in. (45 mm) approx.

PRICE £13.2.0 EACH

(Discount for quantity) Prompt Delivery

Write or telephone for 12 page comprehensive brochure, Publication 994E, giving a wide range of circuit applications and data, to George Kent Ltd., General Industrial Contracts Dept., Luton 2440, Ext.8.

KENT

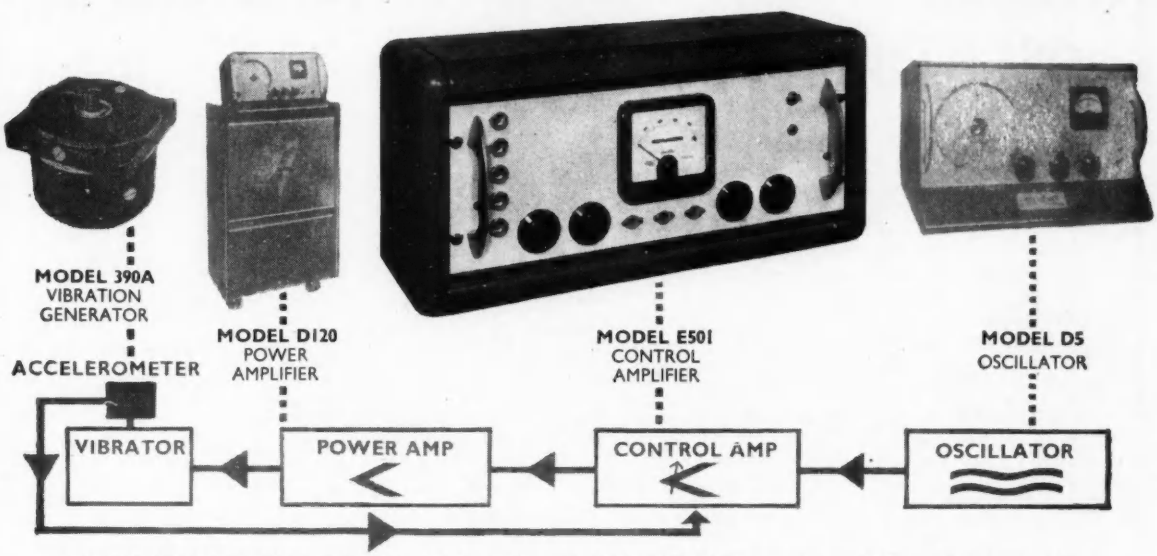
GEORGE KENT LIMITED · LUTON · BEDFORDSHIRE · ENGLAND

Factories, Subsidiary Companies and Branch Offices in London · Resolven · Hitchin · Toronto · Montreal Vancouver · Melbourne Sydney · Johannesburg · Salisbury · Penang · Bangkok · Brussels · Krefeld · Vienna

EE 8064 *for further details*

VIBRATION EQUIPMENT

E 501 COMPLETES THE SYSTEM



THE CONTROL AMPLIFIER MODEL E.501 completes the GOODMANS Vibration System. It is capable of controlling vibration parameters to a level which can be pre-set or programmed from external source. This unit consists of:

a special input stage	a metering circuit	a compressing amplifier and
a head amplifier	an error detector stage	a cathode follower

Under suitable circumstances, an error of 36 dB can be compressed to about 3 dB. The amplified and rectified output from a suitable vibration pick-up is compared with a pre-determined direct voltage, to derive a signal indicative of the error of the vibration level from the desired value. The error signal controls the compressing amplifier, to which an external sine wave oscillator supplies alternating input, thus giving a sine wave signal of frequency determined by the oscillator setting, but of such amplitude that it will produce the correct level of vibration (after passing through a power amplifier if necessary). Working frequency range is from 20 cycles to 10 kilocycles, but response can be obtained beyond these limits.

Input sockets are provided for FIVE signal sources, which can be switch selected at the input of the special cathode follower; for crystal accelerometers of sensitivity from 10 to 20m V/g the meter sensitivity adjustment can be set for full scale values of 10 g and 50 g respectively on the two ranges provided. The specially designed input cathode follower enables crystal accelerometers to be used with cable lengths over 30 ft. without disadvantage.
A co-axial socket is fitted which provides an output from the cathode follower stage, and is suitable for connecting directly to any conventional cathode ray oscilloscope without additional impedance conversion. An oscillator input signal of 150 mV r.m.s. is suitable and a maximum output of 4 V r.m.s. can be provided by the amplifier. At an output level of 1 V the total harmonic distortion is less than 2%.

SPECIFICATION

Frequency range	20c/s to 10kc/s
Signal input impedance	50Mohm approx. in parallel with 2% of cable capacity + 10pF.
Signal amplifier gain	34dB to 40dB (preset).
Meter sensitivity	10g peak F.S.D. and 50g peak F.S.D. at accelerometer sensitivity of 10-20mv/g.
Meter accuracy	± 10%
Rectifier function	peak
Required Oscillator input	150mV into 1megohm.
Output	4V r.m.s. max.
Distortion	1% at 1V r.m.s. output.
Output impedance	700 ohms nominal in series with 1mF.
Correction	At a working level of 25g, an error of 36dB is corrected to 3dB.
Compression criterion	peak signal
Mains supply	200V to 245V, 100V to 145V, 50c/s to 60c/s.

GOODMANS *Vibration Equipment*

GOODMANS INDUSTRIES, LIMITED

AXIOM WORKS · WEMBLEY · MIDDX · ENGLAND
Telephone: WEMbley 1200 (8 lines)
Cables: Goodaxiom, Wembley, England.

GD.22

ENQUIRY FORM

TO GOODMANS INDUSTRIES, LIMITED
AXIOM WORKS · LANCELOT RD. · WEMBLEY · MIDDX. ENGLAND

We are interested in the following:—

- ☐ Control Amplifier E501
- ☐ General Catalogue
- ☐ Equipment to vibrate load of ..... lb at ..... g (..... in) ..... c/s to ..... c/s
- ☐ Suitable driving equipment
- ☐ A vibration system for the duty of .....

Name .....

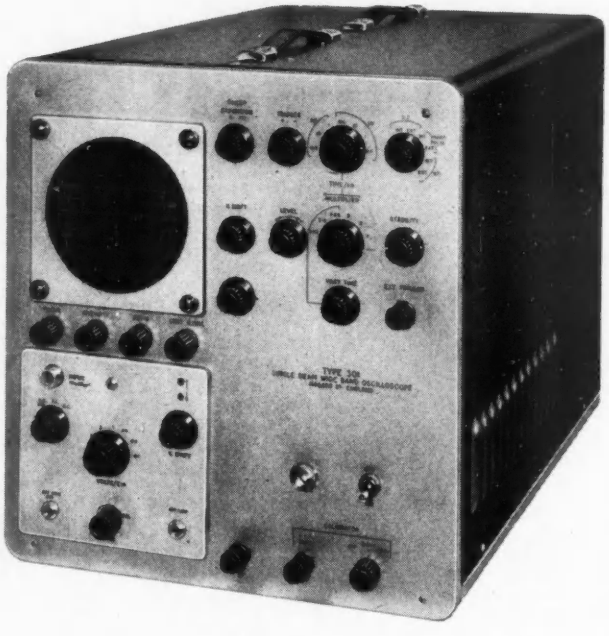
Company .....

Address .....

Please mark details required. A22

A NEW HIGH SPEED OSCILLOSCOPE

Model 301 D.C. to 40 Mc/s.



Designed around the latest type of high sensitivity cathode ray tube, this instrument provides all the essential features of a wide band oscilloscope with accurate measuring facilities and an exceptionally wide range of sweep speeds. The aim has been to get these features incorporated in the least complicated manner, resulting in a compact, rugged and reliable design produced to the highest standard of workmanship at an economical price.

CATHODE RAY TUBE

5" diameter flat faced with a window area of 4×10 cms. Total accelerating voltage applied by means of a helical system is 10KV, resulting in a small beam spot and a trace capable of resolving fine detail.

TIME BASE

Calibrated sweep times from 0.5 sec to 0.1 μsec per cm. accurate within 2% by direct reading of time per cm. An uncalibrated fine control increases the maximum sweep time to 1.2 sec/cm. or 12 secs for a full screen sweep of 10 cms.

Sweep expansion ×10 reduces the minimum sweep time to 10 mμsec/cm. equivalent to a sweep speed of 1mm. per mμsec. Versatile and highly efficient triggering circuitry provides both repetitive and single stroke conditions.

Y AMPLIFIER

Band width . . .	D.C. to 40 Mc/s (-3dB)
Rise time . . .	9 mμsec.
Sensitivity . . .	1 cm per 100 mV.

By switch control the sensitivity can be increased to 1 cm per 10mV over a bandwidth of 2.5 c/s to 20 Mc/s. A nine-step attenuator and a fine gain control extend the sensitivity range to approximately 1 cm per 12V. An RC probe is available with 10—1 reduction factor, extending the range to a minimum of 1 cm. per 120V. A balanced signal delay is incorporated in the amplifier enabling the observation of pulse leading edges.

VOLTAGE MEASUREMENT

A calibrator is provided giving output of 40mV and 400 mV accurate within 2%.

POWER SUPPLIES

Both H.T. and EHT voltages are stabilised over a wide range of mains input voltage variations, and the power supplies are built into the case of the oscilloscope.

NAGARD LTD

18 AVENUE ROAD • BELMONT • SURREY

Tel.: VIGilant 9161-2

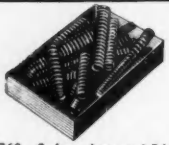
QUALITY
SERVICE
"No Quantity Too Small"
Bronze Copper Aluminium
H. ROLLET & Co. Ltd.
Magnesium Brass Duralumin
Stockists since 1896
LONDON
BIRMINGHAM
LIVERPOOL
MANCHESTER
LEEDS
JEB

Could this be the spring you're looking for?

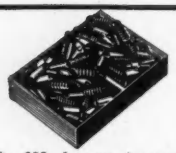
Then you'll find it down below

Whatever you need in the way of springs you'll find in the range of TERRY'S BOXES OF ASSORTED SPRINGS—compression, expansion, long, short, light, heavy—the lot.

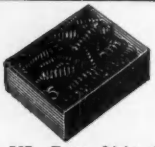
Just the job for you experimental people—a simply unlimited assortment from our tremendous range of springs of every variety. The boxes shown here are only a few examples—why not let us send you our illustrated list showing them *all?*



No. 760. 3 doz. Assorted Light Compression Springs. 1" to 4" long. 22 to 18 S.W.G., ¼" to ½" diam. 6/6 each.

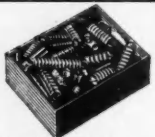


No. 388. ½ gross Assorted Small Expansion Springs. ⅜" to 1¼" long, ⅛" to ½" diam., 18G to 21G. 9/6 each.

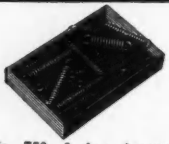


No. 757. Extra Light Compression, 1 gross Assorted, ½" to ⅞" diam., ¼" to 2½" long. 27 to 19 S.W.G. 15/- each.

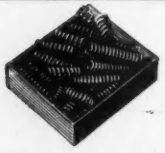
No. 466. ½ gross Assorted Small Expansion Springs ⅜" to 1½" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.



No. 758. Fine Expansion Springs. 1 gross Assorted ½" to ⅞" diam., ¼" to 2" long. 27 to 20 S.W.G. 15/- each.



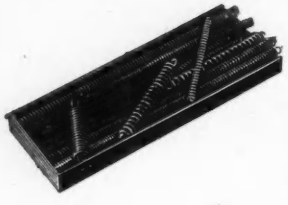
No. 753. 3 doz. Assorted Light Expansion ¼" to ½" diam., 2" to 6" long. 22 to 18 S.W.G. 10/6 each.



No. 98A. 3 doz. Assorted 1" to 4" long, ½" to ⅞" diam., 19G to 15G. 5/6 each.

Cut production costs with Terry Wire CIRCLIPS

We can supply from stock in sizes from ⅛" to ⅜".



No. 1024. 20 Compression Springs 12" long. ⅛" to ½" diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansion 1½" to 12" long. 5/32" to ⅜" diam., 22G to 16G. 24/- each.

★ Interested in Springs? Ninth Edition of "Spring Design & Calculations"—post free 12/6.

TERRY'S

ASSORTED SPRINGS

Herbert Terry & Sons Ltd, Redditch, Worcs.

(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

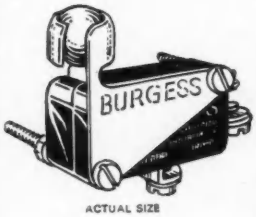
★ Have you a Presswork problem?

If so let us have it and we'll help to solve it for you.

HT 26

O.K.—from any angle!

IT'S **Micro Switchcraft**



ACTUAL SIZE

THE **BURGESS V3**

Miniature Micro Switch with VAB Ball Actuator will operate from any angle.

10 million operations minimum

BURGESS PRODUCTS CO. LTD, MICRO SWITCH DIVISION, DUKES WAY, TEAM VALLEY, GATESHEAD 11. Tel: Low Fell 75322. Telex: 53-229
127 Victoria Street, London SW1. Tel: Tate Gallery 0251 (3 lines)

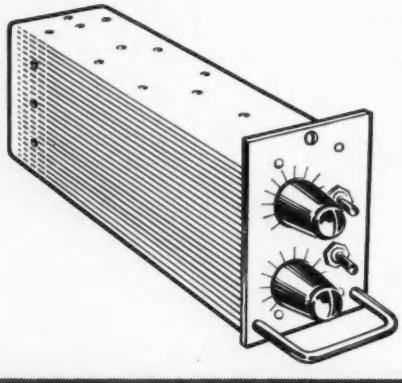
EE 8069 *for further details*

A.W.A

ELECTRONICS

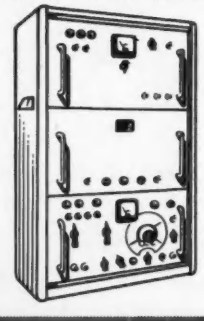
New concepts in electronics have been developed at AWA, as a result of experience with missile systems. Now they have a wider application. Here are some of the new AWA devices now available to industry.

TRANSISTOR GALVANOMETER AMPLIFIER



This Amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attenuator at its input and will accept single ended or push pull signals from ± 1 Millivolt to ±500 volts and will feed a maximum of ±50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.; Frequency response: Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: less than 10 Microvolts; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 7.5 Milliamps/Millivolt, minimum 0.04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

COMEL 8 & 12 SWEEP OSCILLATOR AND VIBRATION CONTROLLER



This unit is designed to drive vibrator amplifiers and has a wide frequency range. The sweep speed is variable over a range 12:1 and automatic frequency sweep facilities are provided. *Frequency Range: 10 c.p.s. to 32 Kc/s in ranges of 5 octaves each. There are 7 switch speeds ranging from 5 secs./octave-60 secs/octave. Variety of Outputs available. Vibration Controller: Input: 4V r.m.s. at appropriate frequency. Output: Up to 100 mV r.m.s. into 600 ohms. Pick Off: Sensitivity 10 mV r.m.s. per "g" peak. Overall Dimensions: 35" x 22" x 14". The Vibration Controller will control ± 40 "g" or as determined at low frequencies by the excursion of the vibrator table.*

All devices are adaptable to suit customers' own requirements. For further information consult:

COMMERCIAL ELECTRONICS DEPT.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD., Baginton, Coventry

MEMBER OF THE HAWKER SIDDELEY GROUP

NOW- THE POSITION AT A GLANCE

Rapid Setting of Co-ordinate Dimensions with *Direct Readings*

British WIEDEMANN R61 Turret Punch Press

The work is positioned under the punch by two handwheels controlling table movement. Direct measuring indicators mounted one above each handwheel enable precise co-ordinate dimensions to be read at a glance. Tripping the press automatically rotates a chart indicating the next table and turret settings.

80,000 lb. punching pressure—20, 24 or 28 punching stations.
Maximum plate size 100" x 60".

There's a Wiedemann Turret Punch Press for every short and medium run piercing job.

Write for technical brochure

DOWDING & DOLL LTD
346 KENSINGTON HIGH STREET. LONDON, W. 14
Telephone WESTERN 8077 (8 lines) Telegrams ACCURATOOL HAMMER LONDON

167

EE 8071 *for further details*

LUXOL

Polyurethanes

The nearest approach to vitreous enamelling

LUXOL Polyurethane coatings embody the latest discoveries in paint technology which enable — for the first time — cold hardening surface coatings to be obtained, having the nearest approach to the hardness and appearance of vitreous enamelling.

These finishes have, amongst other properties; excellent water and mild chemical resistance; good exterior durability, low flame spread and heat resistance up to 400°F., excellent resistance to crude oil, fuel oil, petrol, benzol, etc., and curing at a low ambient temperature.

The LUXOL Polyurethane Coatings comprise:-

1 **Primer for ferrous and non-ferrous metal. Ref: GR.142.**

2 **A Primer Filler for porous surfaces including wood. Ref: GR.167.**

3 **Pigmented and Clear Finishes.**

These coatings are all two-pack materials.

For complete specification, samples and literature post this coupon today.

Please send complete details of the LUXOL Polyurethane Coatings, to:

NAME.....

ADDRESS.....

.....

E.E.

.....

BRITISH PAINTS LIMITED

Industrial Finishes Division,

PORTLAND ROAD, NEWCASTLE UPON TYNE, 2.
CREWE HOUSE, CURZON STREET, LONDON, W.1.
31, WAPPING, LIVERPOOL.

BELFAST, BIRMINGHAM, BRISTOL, CARDIFF, GLASGOW, LEEDS, MANCHESTER, NORWICH, PLYMOUTH, SHEFFIELD, SOUTHAMPTON, SWANSEA and all principal towns.

Reliable Performers

"BELLING-LEE" GLASS SEALS

L.1440 SINGLE TERMINAL GLASS SEAL
L.1441 RECTIFIER GLASS SEAL
L.1442 CLASS 30 TRANSISTOR SEAL
L.1459 LEAD-THROUGH GLASS SEAL

	L.1440	L.1441	L.1442	L.1459
Type	Compression	Compression	Matched	Matched
Voltage	1200 V	2000 V	1200 V	3000 V
Materials: Outer	Steel	Steel	Cobalt Nickel Iron alloy	Cobalt Nickel Iron alloy
Inner	Nickel iron	Nickel iron	Cobalt Nickel Iron alloy	Cobalt Nickel Iron alloy
Finish	Copper*	Nickel*	Gold*	Tinplate*

* Alternatives available

This new range embodies special manufacturing techniques to ensure that very reliable performance is maintained even under the most adverse conditions.

The single terminal glass seal L.1440 is primarily designed for individual leads to a power transistor, although it could be used in certain applications where a single insulated wire has to be hermetically sealed into equipment.

L.1441 is a seal designed for use with silicon or germanium rectifiers and conforms dimensionally to an American standard for this type of component.

The transistor seal L.1442 consists of a matched seal with three wires and a pressed metal case. This conforms to an American Jetec 30 specification and is intended for use with low power transistors.

L.1459 is a hermetically-sealed terminal, now being made by improved techniques.

Most "Belling-Lee" products are covered by patents or registered designs or applications therefor.

Regd.

R.E.C.M.F.
EXHIBITION
STAND 30

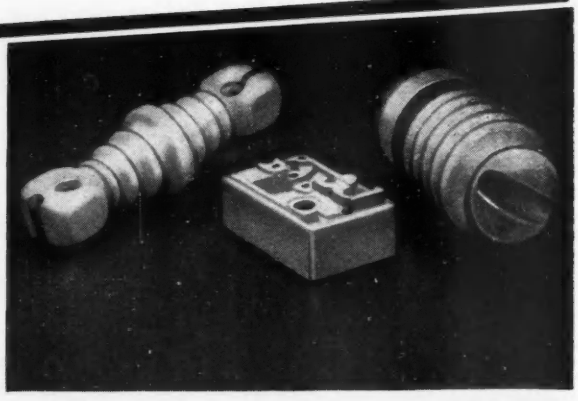
BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND
Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

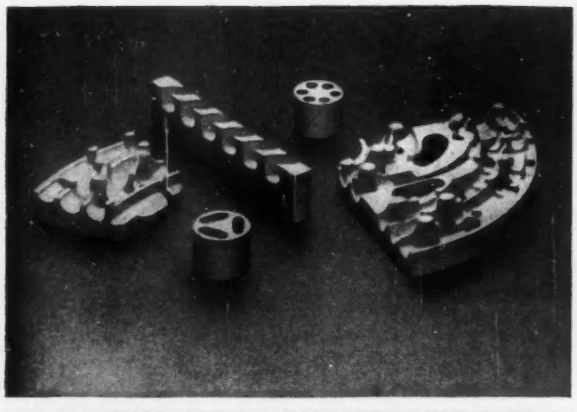
TERMINALS · PLUGS & SOCKETS · THERMAL DEVICES
FUSES · INTERFERENCE FILTERS · RECEIVING AERIALS

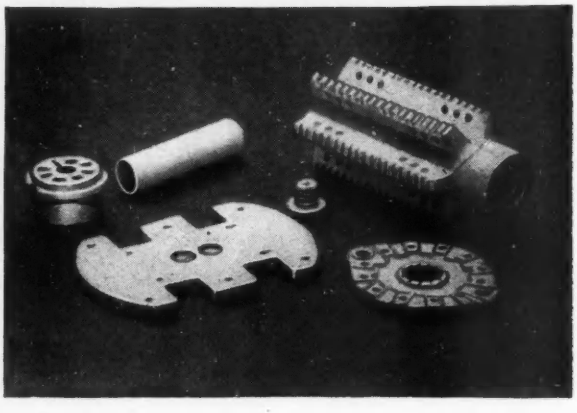
Bullers CERAMICS

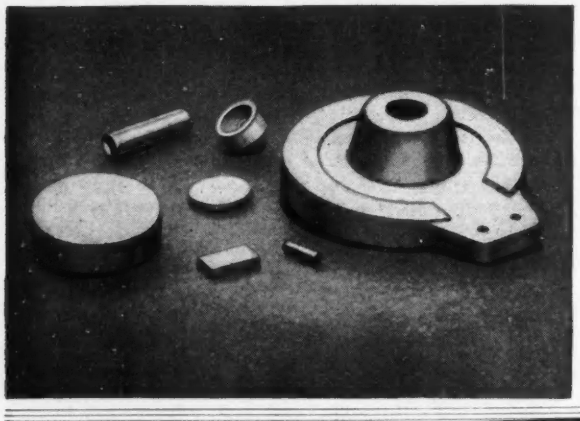
FOR INDUSTRY

High quality material and dimensional precision are attributes of Bullers die-pressed products.
Prompt delivery at competitive prices.









We specialise in the manufacture of

PORCELAIN
for general insulation

REFRACTORIES
for high-temperature insulation

FREQUELEX
for high-frequency insulation

PERMALEX & TEMPLEX
for capacitors

BL12A

BULLERS LIMITED
MILTON · STOKE-ON-TRENT · STAFFS
Phone: Stoke-on-Trent 54321 (5 lines) · Telegrams & Cables: Bullers, Stoke-on-Trent
Ironworks: TIPTON, STAFFS Phone: Tipton 1691
London Office: 6 LAURENCE POUNTNEY HILL, E.C.4 Phone: MANsion House 9971

EE 8074 *for further details*

CIRCUIT MAGNIFICATION METERS

INDUCTANCE CAPACITANCE

- **Direct reading of 'Q' Range 10-400**
- **Frequency Range 100 kc/s-100 Mc/s**
- **Rapid calculation of 'L' and 'Z' by scales incorporated**
- **'Q' Comparison (Model T2 only) Range ±10%**
- **No 'Set Zero' problem**

by

The 'Q' meters Models T1 and T2 provide a convenient method of making R.F. measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The two models are identical except that the Model T2 provides additional facilities for comparing 'Q', inductance and capacitance, and is most suitable for the production testing of coils.

Model T1 nett price in U.K. **£65**

Model T2 „ „ „ „ **£75**

Full technical details of Model T1 in leaflet No. M31 and of Model T2 in leaflet No. M44.

Advance

—to be sure!

STANDARD INDUCTORS **TYPE Q101**

Consisting of 12 coil units covering inductances from 0.1 μH to 30 mH for use with the Advance 'Q' meters. Individually calibrated these coils are 'standards' for the laboratory.

Set of 12 Inductors in carrying case ... **£42.0.0** nett price in U.K.

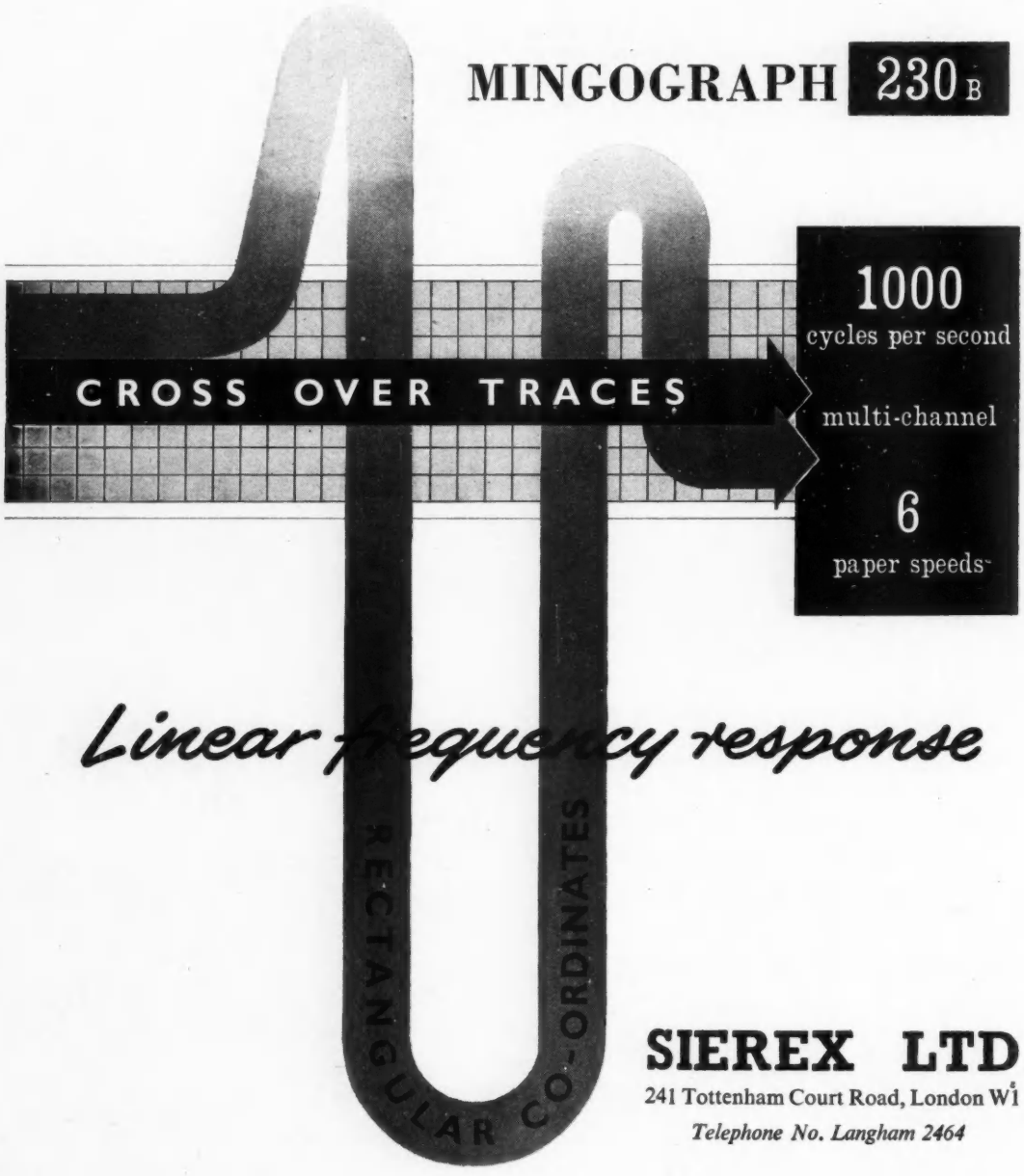
Individual Inductor ... ... **£3.2.6** nett price in U.K.

Full technical details in Leaflet No. M.55

GD72 **Advance COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444**

A revolution in Oscillographs

The Mingograph 230B permits direct recordings to be obtained of approximately ten times greater frequency range than has previously been possible. It is an outstanding advance in the field of scientific and industrial measuring instruments.



SIEREX LTD

241 Tottenham Court Road, London W1

Telephone No. Langham 2464

EE 8076 *for further details*

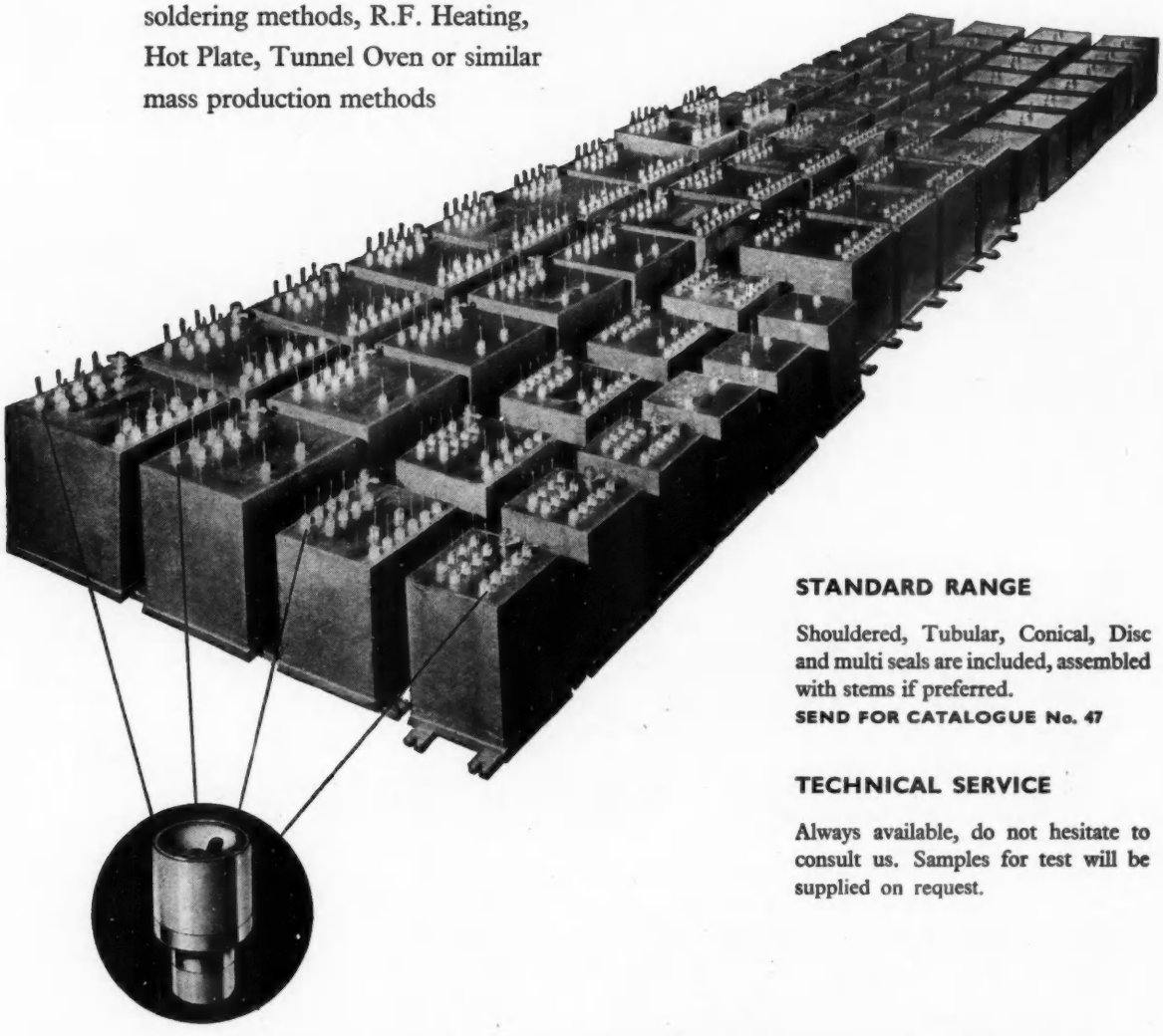
Hermetic Sealing

STEATITE & PORCELAIN
NICKEL METALLISING
Quality Approved (Joint Service R.C.S.C.)
WILL MEET THE MOST EXACTING REQUIREMENTS

METALLISED BUSHES

Perfect Terminations

—made readily without special precautions by semi-skilled labour, employing simple hand soldering methods, R.F. Heating, Hot Plate, Tunnel Oven or similar mass production methods



STANDARD RANGE

Shouldered, Tubular, Conical, Disc and multi seals are included, assembled with stems if preferred.
SEND FOR CATALOGUE No. 47

TECHNICAL SERVICE

Always available, do not hesitate to consult us. Samples for test will be supplied on request.

STEATITE & PORCELAIN PRODUCTS LTD.

STOURPORT ON SEVERN, WORCS. **Telephone: Stourport 2271.** **Telegrams: Steatain, Stourport**

SP100

EE 8077 *for further details*

DOWN COME COSTS

AS *Nylon* GOES TO WORK

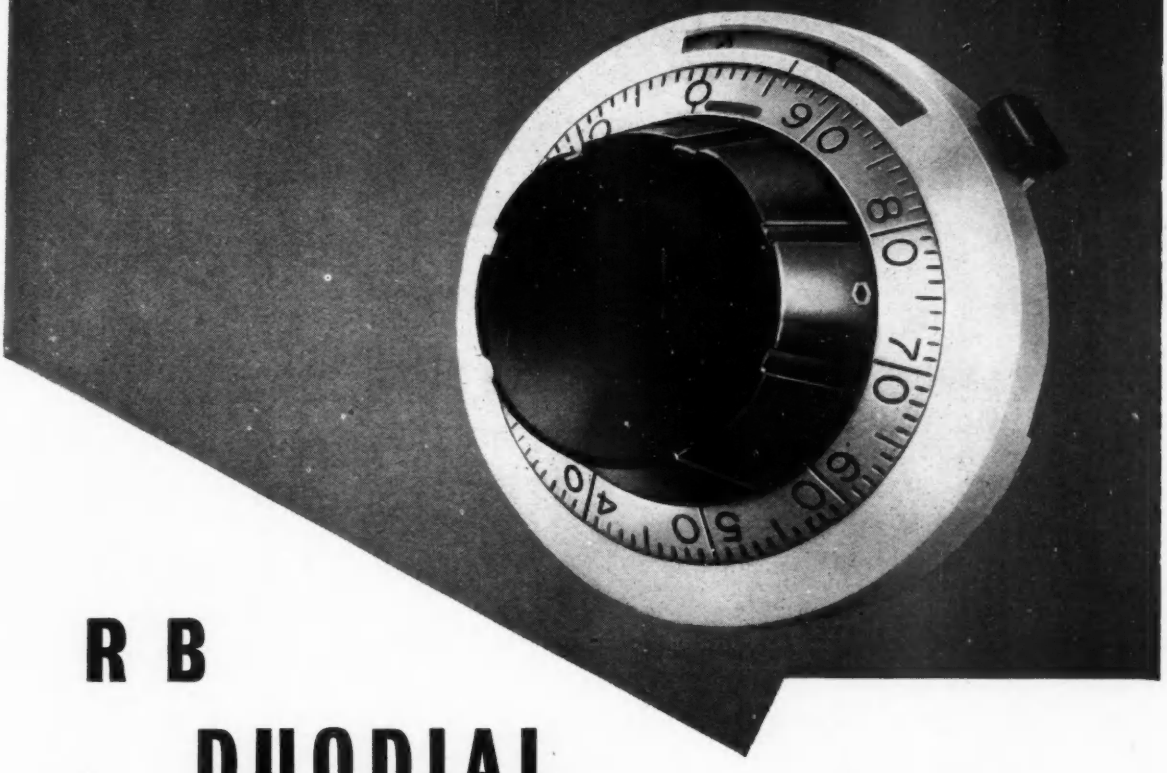
Nylon **WORK WEAR** saves money not only on a cost-for-life basis but also indirectly by reducing running costs, and by increasing efficiency all round. Overalls, Clean Area Suits, Bib and Brace, Boiler Suits, Warehouse Coats—all are available now in nylon. All have these important advantages :—

Easy laundering **Lint-free** **Better hygiene**
Shrink-proof **Longer, smarter wear** **Light and comfortable**

Write to **BRITISH NYLON SPINNERS LIMITED**
Marketing Department, 68 Knightsbridge, London, S.W.1 for your free copy of 'NYLON'S OVERALL ADVANTAGES'

B Nylon S

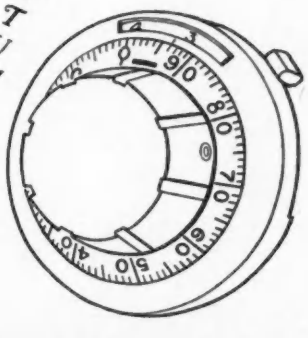
BECKMAN INSTRUMENTS
LIMITED



R B
DUODIAL

Turns Counting Dials are available for use with Helical Potentiometers and variable Capacitors and with many electrical, mechanical, hydraulic and pneumatic devices where accurate counting of full turns and hundredths of turns is required. They may also be used for micrometer type readout with devices such as valves or to count the revolutions of power driven mechanisms.

ACTUAL SIZE



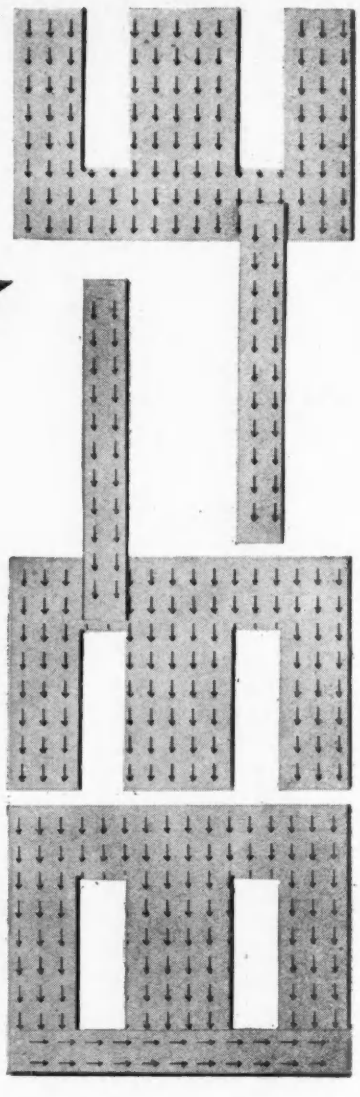
Of a range of Dials available from Beckman, the RB type is available from Scottish production and this type is equipped with a positive vibration proof lock.

For further details contact

WINSTON
ELECTRONICS LIMITED

GOVETT AVENUE SHEPPERTON MIDDLESEX Walton-on-Thames 6321

Ingrained Efficiency



Now that grain oriented steel is readily available, we can design and manufacture transformers on laminations of this material. These are smaller, lighter and cost much less than their C-core equivalents.

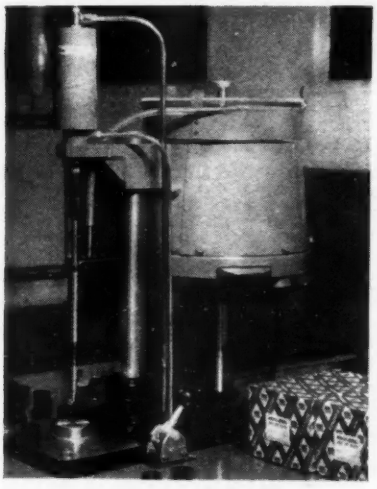
We make our own laminations and can, therefore, ensure that the maximum advantage is gained from this greatly improved core material. By having all the manufacturing processes together and by rigid quality control, we have established our reputation as the leading transformer manufacturers to the Electrical, Radio and Television Industries.

Our technical service is immediately at your call. Why not make use of it?

Hinchley TRANSFORMERS

R. E. C. M. F.
STAND 91

HINCHLEY ENGINEERING CO. LTD., DEVIZES, WILTSHIRE. TEL: DEVIZES 573/5



a ready-made solution to many problems in plastics

HELI-COIL*

push type insert

A metal screw thread insert
that eliminates tapping, solid bushing...
and wastage of time and materials...
has saved more than ½d. per hole!

The Heli-Coil Push Type Insert—an epoch-making development—makes the strongest possible appeal to the progressive technician. It opens up a whole new field of simplification and improvement by providing low-cost, secure fastening of non-structural parts for the high production market. In a quick, simple operation the Heli-Coil Push Type Insert permits the insertion of ready-made self-anchoring female threads in plastic parts and light alloy materials. Difficulties caused by the poor screw thread properties of these materials can now be relegated to the past. No rejects because of blind or untapped inserts or inserts with insufficient thread depth will be found on the assembly line. The Heli-Coil Insert, by its nature, cannot be made without a thread.

The Heli-Coil Push Type Insert can be hopper fed and power inserted into the component after moulding, permitting a high speed moulding operation. It is a necessity for the automation production line layout. Installation tooling can be had on purchase or rental. May we make an investigation for you?

For further details write Sales Leaflet APL.40/4.

ARMSTRONG PATENTS CO. LTD. EASTGATE, BEVERLEY, YORKS. Tel. Beverley 82212

* *HELI-COIL is a registered trade mark*

MoS_2 IN AN AEROSOL SPRAY

ROCOL ANTI-SCUFFING SPRAY

applies the new MOLYBDENUM DISULPHIDE dry lubricant

This speedy, convenient method of application is invaluable for 'on the spot' attention, where parts cannot be segregated for special treatment. Strongly recommended to Service and Maintenance Engineers, Machine and Plant Operators, this method of application is ideally suited for assembly and replenishment of dry lubricating films. Excellent for use on engines, open bearings and chains working in extreme temperatures; on slides, runways, moulds, dies and all press working tools.

THE AEROSOL PACK
of 12oz. capacity is available now.

(Single packs 25/- each; 3 doz. packs 24/- each; 1 gross 23/- each). Full instructions for use are printed on each pack.

A Rocol PRODUCT

Write for descriptive leaflet to:—

ROCOL LIMITED

GENERAL BUILDINGS · ALDWYCH LONDON W.C.2 · 'PHONE HOLBORN 1985-6 . ROCOL HOUSE · SWILLINGTON · LEEDS · 'PHONE GARFORTH 2261-2

ndh 11147c

EE 8082 for further details

THE NASHTON RANGE

Now available from stock

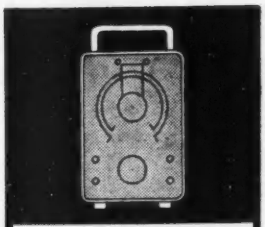
The first five instruments in the 'Nashton' range of miniaturised electronic test gear shown here are now available from stock. Instruments that are to become available in the near future include:—The Flash Tester, Shorted Turn Detector, Transistorised Power Supply and Transistorised Quadrature Oscillator. For full information write to Nash and Thompson Ltd., Oakcroft Road, Chessington, Surrey, or to your nearest area agent.

AREA AGENTS

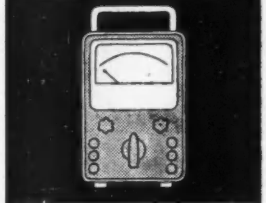
SCOTLAND	Elesco Electronics Ltd., *2 Fitzroy Place, Glasgow, C.3. (Tel: CENTRAL 1082/3)*
NORTHERN ENGLAND	Farnell Instruments Ltd., *Wetherby Industrial Estate, York Road, Wetherby, Yorks. (Tel: Wetherby 2691/2)*
MIDLANDS	Hawnt & Co., Ltd., *112-114, Pritchett Street, Birmingham, 6. (Tel: ASTON CROSS 4301)*
NORTHERN HOME COUNTIES	W. J. Picton Ltd., *123a Neasden Lane, London, N.W.10. (Tel: GLADSTONE 2718-4075)*

Nash and Thompson *LIMITED*

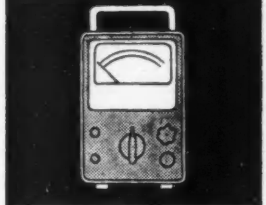
OAKCROFT ROAD, CHESSINGTON, SURREY. Elmbridge 5252



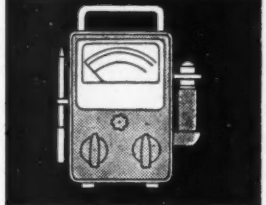
R.C.C. Bridge—*A quick balancing bridge measuring from 5 ohms–500 megohms and 5 pF–500 μF each in three ranges.*



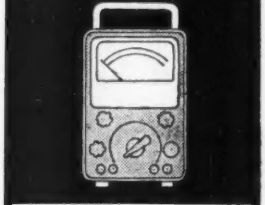
D.C. Valve Voltmeter Microammeter—*A high impedance D.C. Valve Voltmeter reading 1–1,000 Volts and 0.1–100 microamps f.s.d. over seven ranges.*



Sensitive Valve Voltmeter—*An audio frequency A.C. Voltmeter providing 10 ranges from 30 m.V. to 300 Volts f.s.d.*



A.C./D.C. Valve Voltmeter—*Six A.C. ranges from 1–300 Volts f.s.d. up to 200 Mc/s and seven D.C. ranges from 1–1,000 Volts f.s.d. at high impedance.*



Ohmmeter—*A D.C. measuring instrument reading from 10 ohms–10,000 megohms with a high degree of accuracy.*

EE 8083 *for further details*

CONNOLLYS

FIRST with the NEW

BULK PAK FOR WINDING WIRE

CONYPAK

A few of the advantages of winding wire supplied in Conypaks are as follows:-

Continuous long production runs.

Output increased due to reduced "down time" of the winding machines.

None of the troubles sometimes experienced with badly wound reels.

Your efficiencies improved by an avoidance of scrapped short ends, which so often occur when wire is supplied on reels.

Packed in sealed containers, the wire is free from contamination.

Appreciable financial saving.

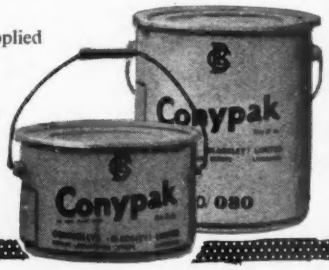
Keeps the winding operatives happy, the wire being more "dead" or less springy, giving an improved coil winding quality.

Simplification of returned empties.

POSTPAK

For ease of handling and storage the larger sizes of Conypaks can be supplied in steel stacking stillages or "Postpaks."

Wire sizes as fine as 36 s.w.g. can be supplied in Conypak packaging. The 50 lb. and 25 lb. Conypaks may be stacked and handled with ease. Please write for full details available in our Booklet Ref. C108-C.



THE LARGEST MANUFACTURERS OF FINE ENAMELLED WIRE IN THE WORLD AND THE FIRST TO INTRODUCE BULK PACKAGING OF WIRE IN GREAT BRITAIN

CONNOLLYS (BLACKLEY) LIMITED · KIRKBY INDUSTRIAL ESTATE · LIVERPOOL

Phone: SIMonswood 2664 · Telex No. 62-247 · Grams: 'SYLLONNOC' LIVERPOOL-TELEX

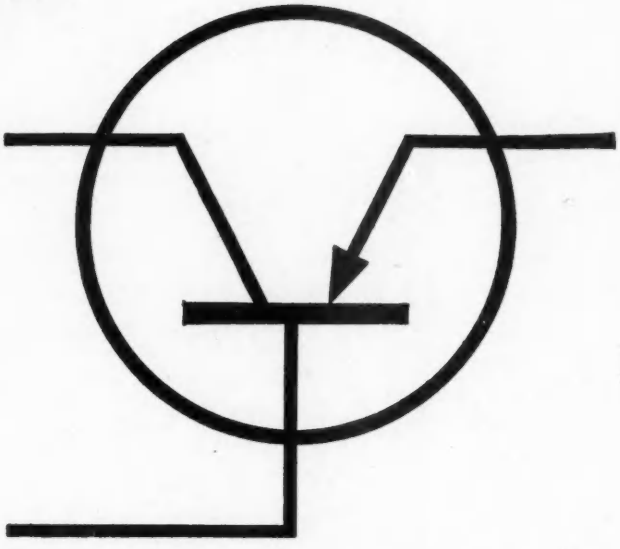
BRANCH SALES OFFICES · SOUTHERN SALES OFFICE and STORES: 23 Starcross Street, London, N.W.1. · Phone: EUSTON 6122

MIDLAND SALES OFFICE and STORES · 39-44 Watery Lane, Bordesley, Birmingham 9 · Phone: VICtoria 4991 · Telex No. 33-309

If the semiconductor data sheet has been detached please write for a further copy to TEXAS INSTRUMENTS LIMITED, DALLAS ROAD, BEDFORD

If the semiconductor data sheet has been detached please write for a further copy to TEXAS INSTRUMENTS LIMITED, DALLAS ROAD, BEDFORD

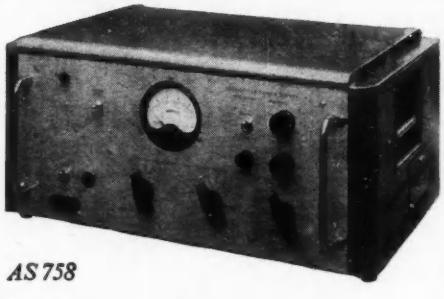
JUST THE TICKET *for any collector!*



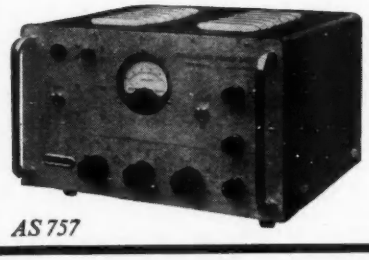
Transistors feel really secure fed from Solartron Transistor Power Supplies—precision rack, bench or sub-unit instruments built to the highest standards of craftsmanship in electronic engineering.

Real 'collector's pieces' in fact!

With assured fast response to load transients and providing highly stable output voltages inside ± 7% mains input change, this new Solartron range of Power Supplies offers the right unit for any transistor research task—or sub-units for direct incorporation into production equipment. Just the choice too to replace batteries—no worries of unobserved voltage decay or finding an exact supply level.



AS 758



AS 757

All bench units have 3-dial decade switching, with its inherently simple resetting facilities, also automatic overload cut-out and load current metering. The sub-units together cover the voltage range zero to 50 volts, with 3 V coarse adjustments and ±1.5 V fine control. Each sub-unit has a subsidiary 5 V (nominal) stabilised output, giving 0—10 mA.

Semiconductor devices are used throughout for control and rectification and all other components have been selected to ensure satisfactory operation up to 35° Centigrade, even at maximum load current and with mains input 7% above nominal. Due to careful design of control circuitry, capacitative loading may be used throughout the whole range of Solartron Transistor Power Supplies, without danger of instability.

Summarised specifications

	AS 757	AS 758	AS 759	AS 852	AS 854	AS 855
	Bench	**Bench or rack**	**Sub-Unit**	**Bench or rack**	**Sub-Unit**	**Sub-Unit**
Output voltage :	± 0 – 50	± 0 – 30	± 1·5 – 13·5	± 30 – 50	± 11·5 – 32·5	± 32·5 – 50
Output current :	0 – 1A	0 – 10A	0 – 1A	0 – 10A	0 – 1A	0 – 1A
Output resistance :	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω	0·01 Ω
Output Z to 100 Kc/s:	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω	0·2 Ω
Stability factor greater than :	200 : 1	150 : 1	200 : 1	150 : 1	200 : 1	200 : 1
Ripple and noise (peak to peak) :	1 mV	1 mV	1 mV	1 mV	1 mV	1 mV
Mains input :	90/130 Volts, 200/240 Volts. Permissible deviation ± 7%					
Dimensions :	12½" × 8" × 13" (33x21x33cm.)	22" × 10½" × 16" (56x27x41cm.)	7¼" × 5¼" × 5¼" (18x15x14cm.)	22" × 10½" × 16" (56x27x41cm.)	Appx. 8" × 6" × 6" (20x15x15cm.)	Appx. 8" × 6" × 6" (20x15x15cm.)
Appx. weight :	25 lbs. (11·5 kg.)	55 lbs. (25 kg.)	7½ lbs. (3·5 kg.)	60 lbs. (27 kg.)	8 lbs. (3·8 kg.)	8 lbs. (3·8 kg.)
Price:	£95	£210	£55	£180	£80	£65

SOLARTRON

THE SOLARTRON ELECTRONIC GROUP LIMITED

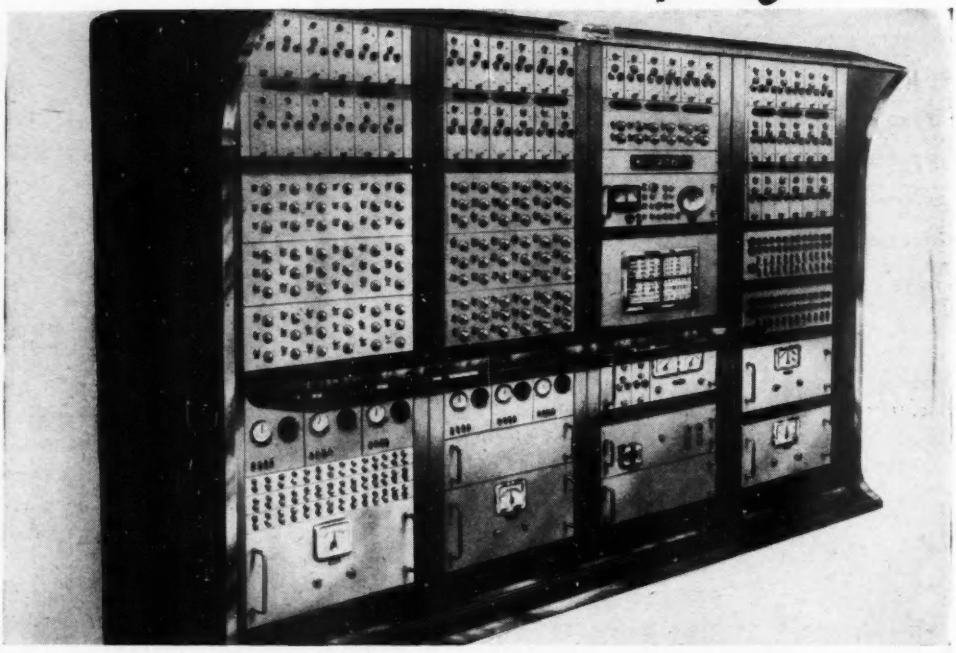
THAMES DITTON · SURREY · ENGLAND · *Telephone :* EMBerbrook 5522

Telegrams and Cables : Solartron, Thames Ditton · International Telex : 23842 Solartron T.Dit.

EE 8085 *for further details*

COMPUTOR

sub-assemblies *simplified!*



This is an artist's impression of the Solartron 'SPACE 48'— SPACE standing for Solartron Precision Analogue Computor Equipment. At least 100 BRIBOND printed circuits of different sizes will be used in this equipment.

with Printed Circuits *Gold-plated* for reliability

Bribond Printed Circuits complement modern electronic planning and component manufacture. For Bribond have mastered the technique of double-sided Printed Circuits, with all the advantages of gold-plating and notation. Electronic engineers will be quick to appreciate the benefits of gold-plating to check corrosion and simplify soldering and of notation for ease of component insertion. These two advances are considered by Bribond to be essential for quality computor installations.

Each individual circuit is subjected to rigid inspection at three vital stages of production, enabling us to offer a completely *reliable* service, both as regards *quality* and *delivery*. This applies whether your order is for one or one thousand.

Only by achieving this high standard can Bribond claim a place in the highly technical field of computor construction. We welcome the opportunity to collaborate with manufacturers and to provide the printed circuits that so greatly assist in the simplification of the complicated process of assembly. Send to the address below for full details and samples.

48-hour Prototype Service

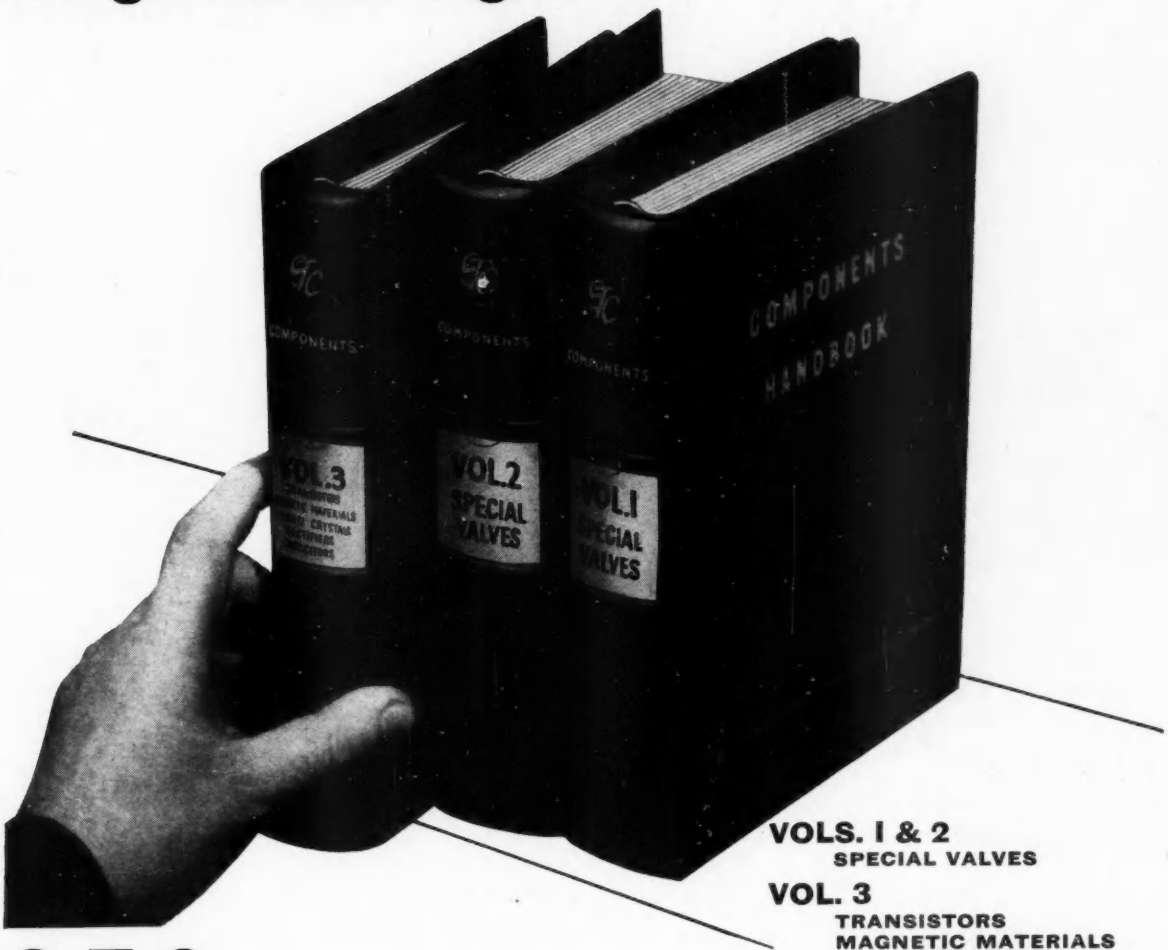
A special Prototype Service can produce the initial experimental circuit on which final production can be planned. All we need is a clean circuit image, larger than actual size on a dimensionally stable drawing material.

BRIBOND *printed circuits*

BRIBOND LTD., BURGESS HILL, SUSSEX. *Telephone:* BURGESS HILL 85611

EE 8086 *for further details*

A new service for equipment designers and engineers



VOLS. I & 2
SPECIAL VALVES

VOL. 3
TRANSISTORS
MAGNETIC MATERIALS
QUARTZ CRYSTALS
RECTIFIERS · CAPACITORS

VOL. 4 *(to be issued in June)*
BRIMAR VALVES

S.T.C.
Components Handbook

Equipment designers and engineers will find extensive use for this new service by S.T.C. Data Sheets on the full range of S.T.C. Components are included in these three loose-leaf volumes and amendments and additions will be made at quarterly intervals. The cost to subscribers of £1 per annum will include the binders, data sheets and all subsequent amendments.

** This applies in U.K. and N.Ireland only. Overseas Subscribers are requested not to send fee with application.*

*Please register me as a subscriber for the S.T.C. Components Handbook. A Cheque/P.O. for £1 is enclosed.**

Name.....

Company.....

Address.....

.....

STC COMPONENTS GROUP

Standard Telephones and Cables Limited

CONNAUGHT HOUSE · ALDWYCH · LONDON WC2

POLYESTER DOUGH MOULDING COMPOUND for

- Transformer Housings
- Fire extinguisher nozzles
- Ventilation & Heating Ducts
- Refrigerator door locks and shelf brackets
- Industrial Fuse boxes
- Switchgear Housing
- Coil Formers
- Industrial Switch Dollies
- Heavy duty plugs & sockets
- Contactor bodies
- Vacuum Cleaner Housings
- Insulating handles & covers for electrical appliances
- Double insulation
- Busbar holders
- Slip ring motor insulators
- Boxes & Panels

BEETLE DMC

HIGH DIMENSIONAL STABILITY

GOOD SHOCK RESISTANCE

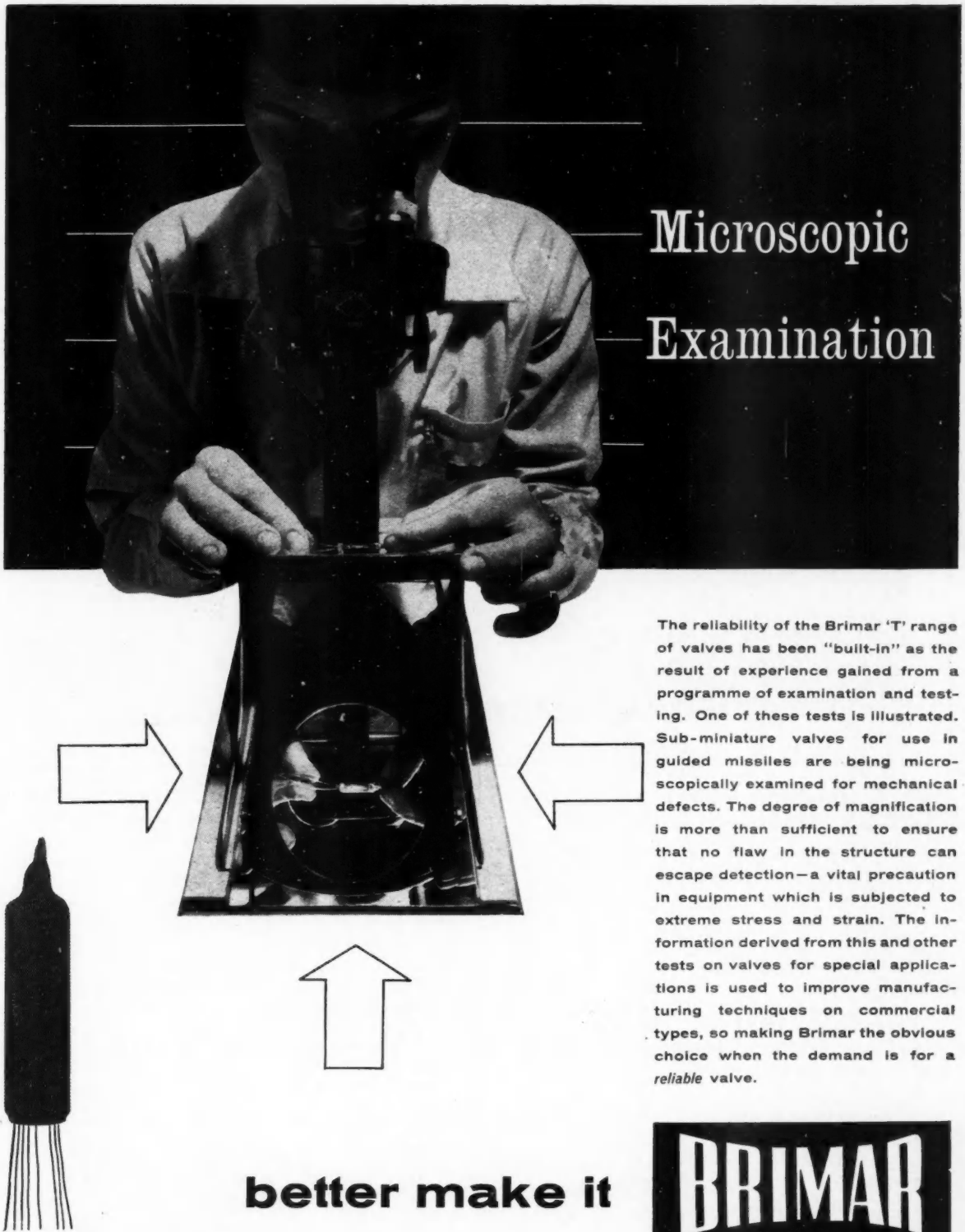
GOOD HEAT RESISTANCE

Beetle DMC is a fibrous dough moulding compound consisting of an unsaturated polyester resin incorporating mineral fillers and reinforcing fibres. It is economical because it is fast and simple to mould under low pressure in conventional compression presses. Mouldings made from this material have high mechanical and electrical strength, excellent dimensional stability and insulating properties. DMC opens up a host of new applications for plastics and in certain cases may be used to replace alloy castings. Two glass-filled grades are available — Grade A for general purposes and for electrical components; and Grade B — a self extinguishing material. Write for full details.

PLUS A **New** GENERAL PURPOSE DMC: SISAL FILLED GRADE C

B.I.P. CHEMICALS LIMITED B·I·P

OLDBURY · BIRMINGHAM · PHONE: BROADWELL 2061



Microscopic Examination

The reliability of the Brimar 'T' range of valves has been "built-in" as the result of experience gained from a programme of examination and testing. One of these tests is illustrated. Sub-miniature valves for use in guided missiles are being microscopically examined for mechanical defects. The degree of magnification is more than sufficient to ensure that no flaw in the structure can escape detection—a vital precaution in equipment which is subjected to extreme stress and strain. The information derived from this and other tests on valves for special applications is used to improve manufacturing techniques on commercial types, so making Brimar the obvious choice when the demand is for a *reliable* valve.

better make it

BRIMAR

STC COMPONENTS GROUP

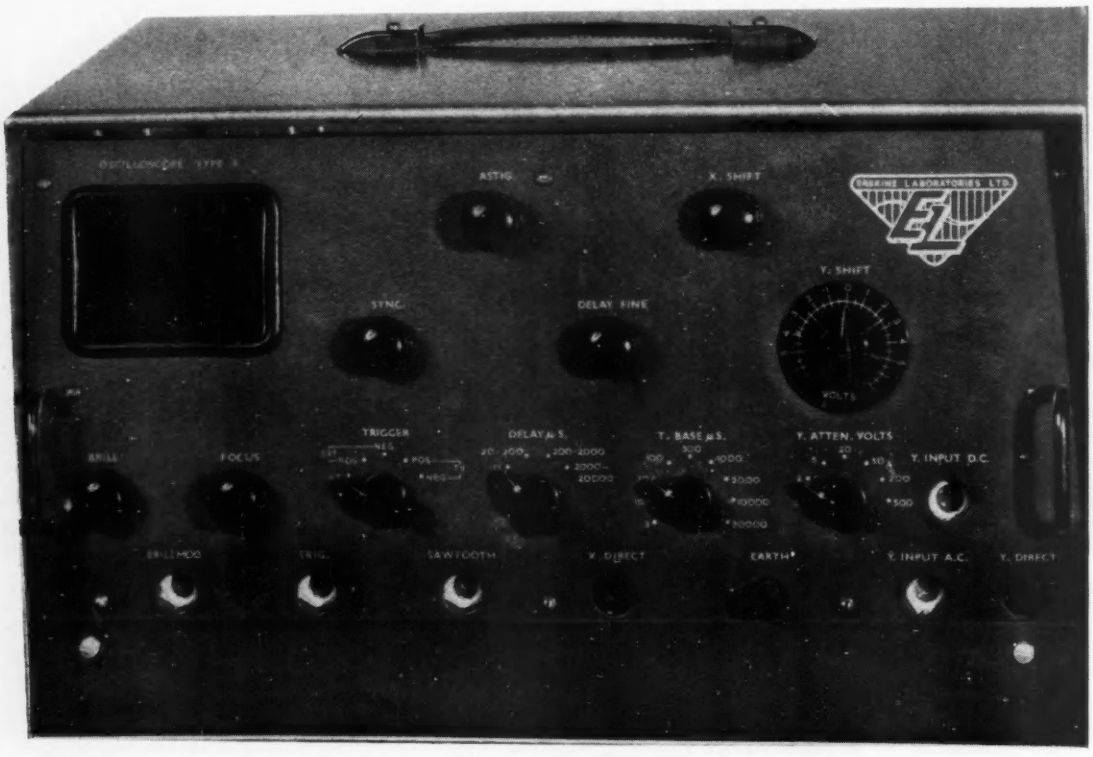
Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

VALVE DIVISION: FOOTSCRAY · SIDCUP · KENT · FOOTSCRAY 3333

EE 8089 *for further details*

GENERAL PURPOSE OSCILLOSCOPE TYPE 5



- **Dimensions—17″ × 10″ × 11″.**
- **Weight—30 lbs.**
- **Time Base—9 preset 3-30,000 microsecs.**
- **Delay—20 to 20,000 microsecs.**
- **X1 & X2 Plates—Direct. Sensitivity—30 volts/cm.**
- **Y1 & Y2 Plates—Direct. Sensitivity—45 volts/cm.**
- **Y Amplifier— Constant Bandwidth. DC to 4 Mc/s (6 db). Constant Gain (× 100). Input Voltages 0.5 to 500.**
- **Z axis socket for Brill. Mod.**
- **Synch.—better than 0.5 volts at Y input.**
- **Trigger—better than 3 volts (R.M.S. sine wave).**
- **Time Base Waveform socket on panel.**
- **C.R. Tube—4 Anode—2¾″ dia.**

The Oscilloscope has a **STABILISED H.T. SUPPLY** which allows a direct reading against calibrated graticules regardless of supply fluctuations. **NO ELECTROLYTICS** are used.

The **DELAY CIRCUIT** allows any part of a repetitive waveform to be viewed up to 20,000 microsecs from synch. edge. This is particularly useful, for instance, for examining T.V. Waveforms line by line up to the next frame.

All circuit components are in a low-temperature area and ventilation is arranged to provide an air flow in at the bottom front and out at the top front. This allows the Dust Cover, devoid of vents, to be a **DUST COVER.** Cable connectors are stowed behind a removable cover at the base of the Front Panel.

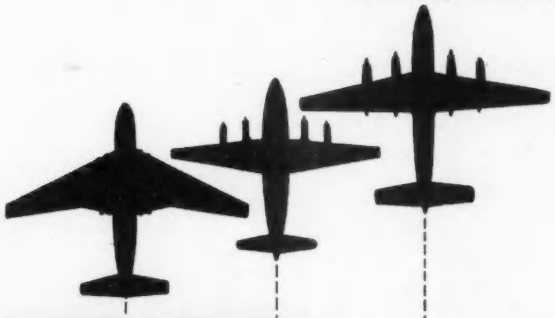
Price £65 Nett Ex Works

Send for full details and photograph of interior to:—

ERSKINE LABORATORIES LIMITED

SCALBY · SCARBOROUGH · YORKS **Tel SCALBY 483**

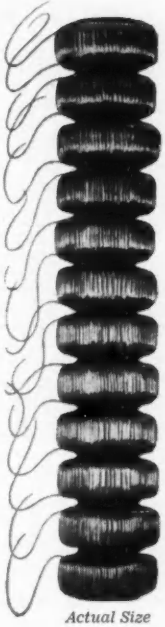
EE 8090 *for further details*



TOROIDAL SUPPRESSION CHOKES

used in all the major airliners including the COMET, VISCOUNT and BRITANNIA

With the greater use of radio and navigational aids on ships and aircraft, it is increasingly important to suppress interference likely to arise from other electrical equipment which is also an inseparable part of modern transport. S.T.C. with over 40 years experience in the development of high grade magnetic materials, now introduce a selection of the many types of chokes which are manufactured for industrial, marine and aeronautical applications.



Actual Size

RANGE OF SIZES AND WEIGHTS

The following table lists the size, weight and normal range of inductance and current rating of several S.T.C. Toroidal Chokes:

SIZE CODE	SIZE				INDUCTANCE & CURRENT RATING
	Outer Diam: cm	Inner Diam: cm	Length cm	Weight gm	(μ and Amp. AC or DC)
C1	1.3	0.7	0.52	3.5	from 10 μ ($\frac{1}{4}$ amp) to 1000 μ (0.1 amp)
C2	2.3	1.2	0.80	14.5	„ 100 „ (1$\frac{1}{2}$ „) to 1000 „ ($\frac{1}{2}$ „)
C3	2.95	1.4	1.3	50.0	„ 100 „ (2$\frac{1}{2}$ „) to 1000 „ ($\frac{1}{2}$ „)
C4	4.1	2.4	1.3	85	„ 100 „ (4 „) to 2000 „ (1$\frac{1}{2}$ „)
C5	4.8	2.7	1.4	130	„ 100 „ (5 „) to 2000 „ (2 „)

STC COMPONENTS GROUP

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

MAGNETIC MATERIALS DIVISION: NORTH WOOLWICH · LONDON · E.16

The design and dimensions are to the international standard. With the sockets, backing plates can be supplied for complete insulation from the chassis.
Please write for Leaflet No. 4992

CINCH

CARR FASTENER CO LTD

STAPLEFORD · NOTTINGHAM

the name to remember for

INDUSTRIAL TYPE TRANSISTORS

BIDIRECTIONAL GERMANIUM TRANSISTORS

(Effectively symmetrical in significant parameters)

TYPES TK 20 B, TK 25 B

For high frequency switching circuits (8 Mc/s and above with the TK 25 B), or small signal amplification.

TYPES TK 21 B, TK 24 B

For intermediate frequency, high voltage switching circuits, or small signal amplification.

ASYMETRICAL GERMANIUM TRANSISTORS

TYPE TK 23 A

For general purpose low and intermediate frequency applications, and telephone and telegraph carrier systems.

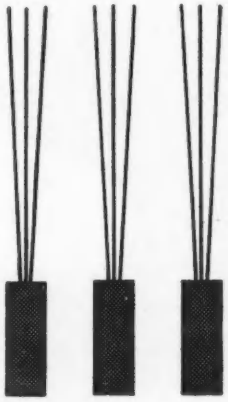
TYPE TK 40 A

For audio and intermediate frequency oscillators and amplifiers requiring high gain and a power output of several hundred milliwatts.

SILICON TRANSISTORS

TYPES TK 70 A, TK 71 A

For amplification, switching and control in extremes of ambient temperature; and having excellent saturation characteristics at high collector currents, unusual in silicon transistors.



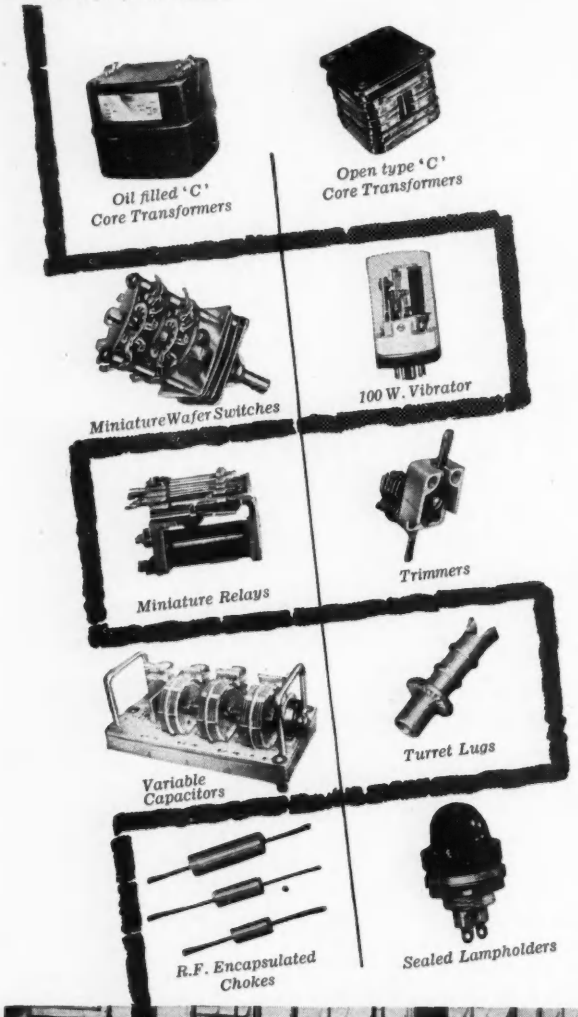
STC COMPONENTS GROUP

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

TRANSISTOR DIVISION: FOOTSCRAY · SIDCUP · KENT

EE 8093 *for further details*



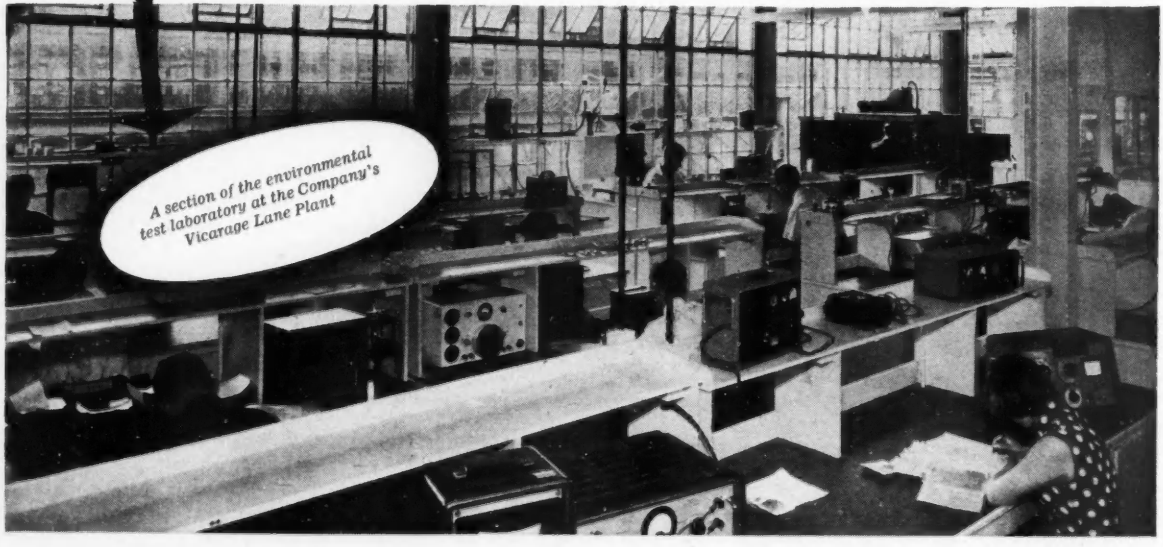
A lot depends on

Plessey

In its various factories throughout the Country, Plessey produces an immense range of Type Approved electronic components. The Company supplies much of the material for vital communications equipment and major research projects, which can range from human voice synthesis to rockets.

Modern electronics technique demands a degree of precision and accuracy rivalled in few other fields—with brains and manufacturing facilities to match. All this is aimed at utter reliability; no component must fail in service. Plessey are proud to be making such a contribution to an exacting science.

Plessey Type Approved components are available to Industry in many forms. Some are illustrated here. To give more detailed information a series of publications exists, and will gladly be sent on receipt of a letter stating your interests.



COMPONENTS GROUP | THE PLESSEY COMPANY LIMITED · ILFORD · ESSEX

TELEPHONE: ILFORD 3040

Overseas Sales Organisation: Plessey International Limited · Ilford · Essex · Telephone: Ilford 3040

CP2

EE 8094 *for further details*

"WHERE DO CAPACITORS COME FROM?"

There's an easy answer to *that* one—without going into the gooseberry bush routine! For when it comes to the Facts of Capacitor Life, they are simple. *All that's newest in capacitors comes from S.T.C.* And just in case this little egghead wants proof of the point, we've listed our current range of capacitors below.

- STANTELAC CAPACITORS
- STANTELUM ELECTROLYTIC CAPACITORS
- MINIATURE STANTELUM ELECTROLYTIC CAPACITORS
- STANTELISED METALLISED PAPER CAPACITORS
- AIRCRAFT AND MARINE SUPPRESSORS

STC COMPONENTS GROUP

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

CAPACITOR DIVISION: SALES DEPARTMENT FOOTSCRAY · SIDCUP · KENT

EE 8095 *for further details*

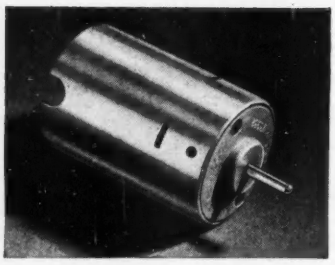
PULLIN

D.C. INSTRUMENT MOTORS

Interservice Standard P.M. Motors

Low voltage, high efficiency, permanent magnet d.c. motors in International Standard Size housings sizes 08 to 18 and designed to operate under the most severe conditions. (Right) The small 08 P.M. 1.75 inches long, 0.75 inches diameter. Giving up to 4 watts mechanical power output Withstands the Climatic Test Conditions of M.O.S. Spec. DTD. 1085B and Interservice Spec. K114/B and K114/J. For 6, 12 or 28v. D.C. operation and is available as a Rate Feedback Tachogenerator.

Type	Torque grm/cm.	Speed r.p.m.
18PM	300	5000
15PM	240	5000
11PM	120	5000
08PM	65	5000



General Drive Motors

Motor Type Series **P.M.1.**

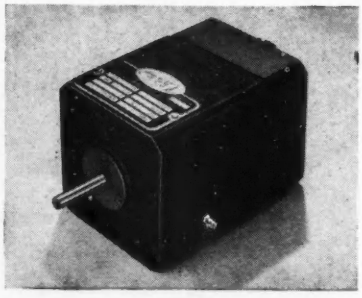
A miniature permanent magnet motor giving approximately 80 grm/cm at 5000 r.p.m.

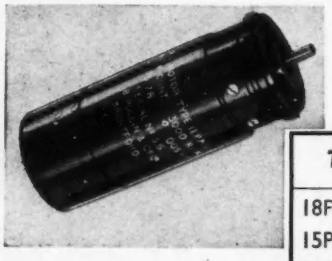
Length: 2 inches, Diameter: 1.3 inches, Weight: 4.5 ozs. In a range of voltages and shaft variations.

Square Bodied Motors

Shunt Wound Field

Type	Torque grm/cm.	Speed r.p.m.
B12	340	3500
B8	275	3500
D6	80	4100





Governed Motors

Totally enclosed centrifugal type governor ensures close and accurate speed control.

Type	Torque grm/cm.	Speed r.p.m.	Control
18FM(G)	250	3000	±1%
15PM(G)	40	3000	±¼%
11PM(G)	120	3000	±1%
PM1CX	80	2000-4000	±3%

R. B. PULLIN'S long precision instrument engineering experience together with the development of new manufacturing processes and techniques is evident in the specification and high performance of Pullin and Pullin — Kearfott components. A comprehensive range of motors and servo-components is listed in our catalogue which will be gladly sent on request.

THE PULLIN GROUP
R. B. PULLIN & CO. LTD.
Measuring Instruments (Pullin) Ltd.
Aldis Brothers Ltd.
Pullin Optical Co. Ltd.
Stanley Cox Ltd.
Donvin Instruments Ltd.

A.C. SERVOCOMPONENTS

PULLIN

Pullin-Kearfott Motor Generators

(Left) The Pullin-Kearfott Size 10 Motor-Damping Generator Type R807 for damping applications where high accuracy, small size and low inertia are required. The low in-phase null makes the R807 ideal for simple rate servos. See also R800, R801 and R806, high performance Motor-Damping and Motor Rate Generators.

Size	Type	Stall Torque grm/cm	Output volts at 1000 r.p.m.	400 c/s
10	R807C	25	0.4	26 v. Operation.
10	R807GC	35	0.5	20 v. Centre Tapped. Mk. 18 Mod. 2
15	R800	105	3	Mk. 12. Mod. 0.
15	R800G	105	3	20 v. Centre Tapped.
18	R801	172	3	Mk. 16. Mod. 0.
18	R806	205	3	High Power.

Pullin-Kearfott Servo Motors

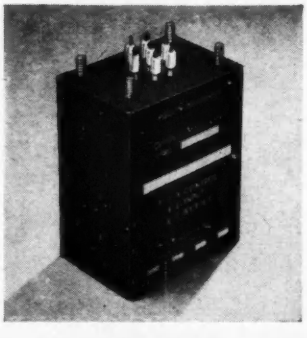
Size	Type
10	RH 118B High Temperature
10	R 124G 20 v. Centre Tapped
10	R 124S 40 v. Centre Tapped

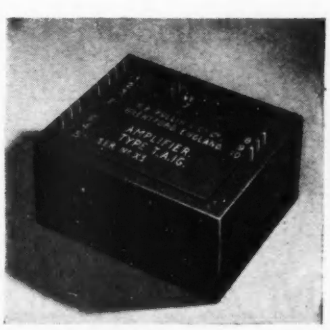
Pullin-Kearfott Synchros

High precision units to N.A.T.O. and Bu-Ord standards. Sizes 11 and 18, 400 c/s 115v and 26v operation. Range includes a 7 terminal Size 11 Control Resolver R982-21B—BuOrd 11R13N4.

Magnetic Output Amplifier

Types R601/604 to provide control phase power for the complete range of Pullin-Kearfott servomotors and motor generators.





Transistor Amplifier T.A.I.G

A miniature resin-moulded germanium transistor amplifier for use with size 10, 11 and 15 servomotors.

R. B. Pullin (parent company of the Pullin Group) with a world-wide reputation for high performance precision instruments and equipment, and the combined resources of the Pullin Group, offer design and development service in all branches of instrument engineering.

ENGINEERS: We are always pleased to hear from qualified engineers seeking interesting and progressive development work in a live and expanding company.

R. B. PULLIN & CO. LTD.

PHOENIX WORKS
GREAT WEST ROAD
MIDDLESEX · ENGLAND

Cables: PULLINCO · WESPHONE · LONDON
Telephone: ISLEWORTH 1212

EE 8097 *for further details*

higher forces with smaller sizes

MAGNETIC DEVICES LIMITED

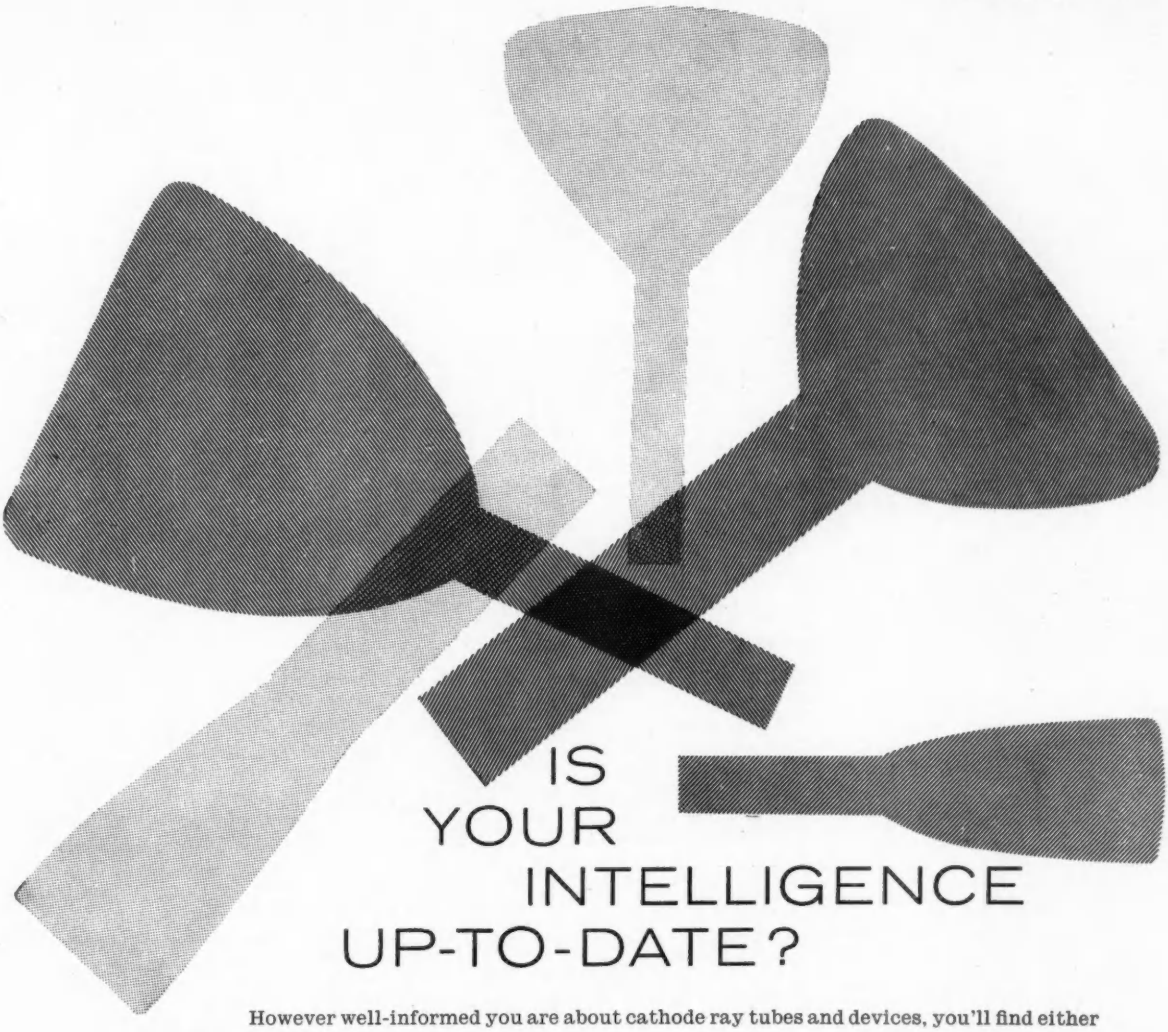
AID & ARB APPROVED

Whatever your solenoid requirement, contact us. We specialise in high performance solenoids, we have the know-how and production facilities.

MAGNETIC DEVICES LTD

NEWMARKET · SUFFOLK · ENGLAND · Phone: Newmarket 3[illegible] (5 lines) · Grams: Magnetic Newmarket

P3035



IS YOUR INTELLIGENCE UP-TO-DATE?

However well-informed you are about cathode ray tubes and devices, you'll find either or both of these publications invaluable. The first, 'Cathode Ray Tubes for Industry'— a handy source of reference to have about—deals broadly but fairly comprehensively with the wide range of tubes available. The second, 'Cathode Ray Devices' contains information on specialized types of CRT devices, among them, tubes for computers, very high speed oscilloscopes and TV monoscope tubes. If you would like copies, please write (or complete the coupon below), and we'll keep you posted.

G.E.C.

'Cathode Ray Tubes for Industry'
'Cathode Ray Devices'

VISIT OUR STAND NO. 180 AT THE R.E.C.M.F. EXHIBITION, PARK LANE HOUSE, APRIL 6-9

The M-O Valve Co Ltd
Brook Green, Hammersmith, London, W.6
a subsidiary of the General Electric Company Limited

Post in unsealed envelope (2d stamp)
TO: THE M-O VALVE CO. LTD., BROOK GREEN, HAMMERSMITH, LONDON, W.6.
Please put me on your mailing list for these and future publications.
NAME .....
FIRM .....
ADDRESS .....
.....
B/4/59

EE 8099 *for further details*

for sound recording and reproduction....

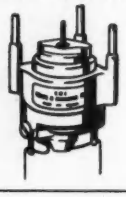
See the E.M.I. range of components

NEW 4-SPEED RECORD PLAYING DECK

Especially suitable for stereophonic record reproduction. Incorporates an auto-trip and finger-tip control speed-change mechanism. Mains and battery versions. Inexpensive and simple design, with the performance of a transcription turntable unit.

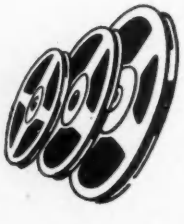
Loudspeaker units

including tweeters and "slot" speakers and combinations recommended for High Fidelity equipment.



Mains and battery motors

suitable for record players, tape recorders, gramophones, and many industrial purposes.



EMITAPE the world-famous magnetic recording tape for professional and domestic use. '77' pen tested; '88' general purpose; '99' Long Play Emitape for instrumentation, computers, telemetry, video and data recordings, etc.

EMIFILM sprocketed magnetic recording film for ciné and teleciné applications.

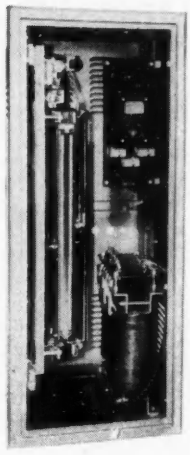
at the Radio & Electronic Component Show

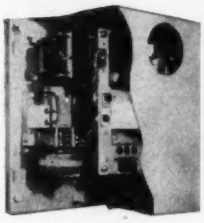
STAND 35

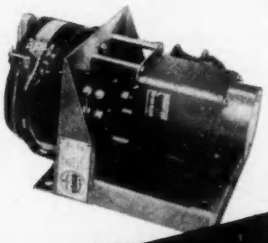
We shall be pleased to answer your enquiries and to discuss individual requirements.

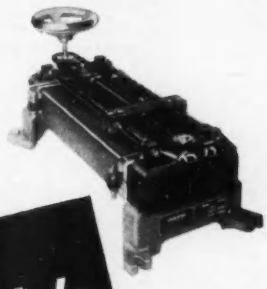
E.M.I. SALES & SERVICE LTD · Hayes · Middlesex · Tel: SOUthall 2468

es/c/s

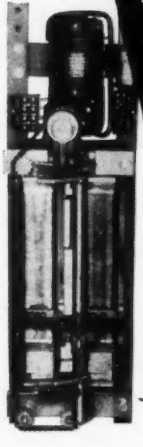


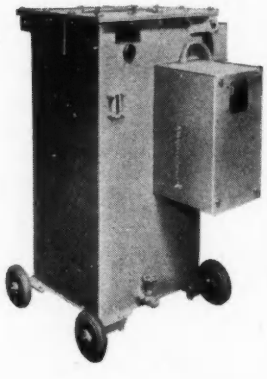


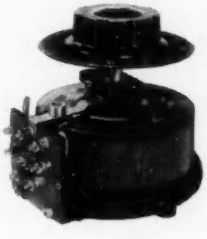


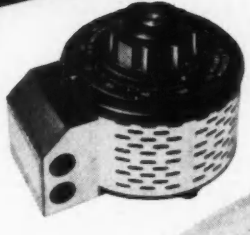


28 Standard Models from 250VA-110kVA









There's a BERCO-BPT VOLTAGE REGULATOR *to meet your need*

Ring HOWard 2411

The BERCO design team will help you with any voltage or current Control problem.

* *Please ask for our Catalogue which will be despatched by return of post.*

THE BRITISH ELECTRIC RESISTANCE CO. LTD.

in association with

THE BRITISH POWER TRANSFORMER CO. LTD.

QUEENSWAY · ENFIELD · MIDDLESEX · Telephone: HOWard 2411

EE 8101 *for further details*

NEW Heathkit **'BUILD-IT YOURSELF' KITS**

CAPACITOR/RESISTOR TEST BRIDGE

MODEL C-3U

Delivered free in U.K.

£7 . 19 . 6 Deferred terms available

This is a most useful instrument in any laboratory or workshop. It is a self-contained A.C.-powered bridge which quickly measures resistors and a very wide range of all types of capacitors—determining capacity, power factor and indicating the degree of leakage. A Dual-Sensitive Magic Eye is used as the indicator of bridge balance. A unique safety-factor is the use of a special spring-return test switch. This automatically discharges the condenser after test so as to eliminate completely the risk of D.C. shock to the operator.

Measurement Ranges:

Capacity: 0·00001 μF (10 pF) to 1000 μF, in 4 ranges
Resistance: 100Ω to 5MΩ, in 2 ranges.
Polarising Voltages: 5, 150, 250, 350 (D.C.).

OTHER HEATHKIT MODELS SUPPLIED AS KITS, delivered free in U.K.—(deferred terms if desired):

S-88 HI-FI STEREO AMPLIFIER KIT. 16 watts output (8 per channel). 0·1% distortion at 6 W/channel. Inputs for Stereo or Monaural—gram., radio and tape recorder. Many special features, including ganged controls—Ultra-linear push-pull output, with multi-loop N.F.B. Beautifully styled metal case, 2-tone grey. £25.5.6.

S-33 POPULAR-PRICED HI-FI STEREO AMPLIFIER KIT. 6 watts output (3 per channel). 0·3% distortion at 2·5 W/channel. 20 dB N.F.B. £11.8.0.

USP-1 HI-FI STEREO PRE-AMPLIFIER. Ideal for low-output Hi-Fi P/U's. Switched inputs—tape, gram., mic.; stereo/monaural. £5.19.6.

SSU-1 HI-FI SPEAKER SYSTEM KIT. A low-cost twin speaker system for Stereo or Monaural amplifiers, ideal for small or medium size rooms. Frequency range: 40-16000 c/s. 8" high-flux bass unit and 4" wide-diffusion treble. Ductive reflex cabinet, supplied "in the white", pre-cut and sanded, for final finish to choice. £10.9.0. (Legs optional, £1.7.0 extra.)

DX-40U 'HAM' TRANSMITTER KIT. Covers all Amateur bands, 80-10m. Power Inputs 75 watts CW, 60 W.pk. c/c. phone. 40 W. to Aerial. Provision for V.F.O. Pi network output coupling. 3 switch-selected crystal positions. 6146 final amp. Filters minimize TVI. £29.10.0.

VF-1U VARIABLE FREQUENCY OSCILLATOR KIT. Doubly screened, stabilized, covers 160, 80, 40, 20, 15 and 10 metres. Ideal for use with the Heathkit DX-40U (or similar) transmitter. £10.12.0.

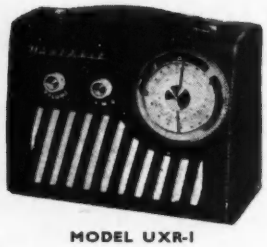
UJR-1 YOUNG EXPERIMENTER'S KIT. An ideal introduction to radio. Any youngster will enjoy building this unusually sensitive and selective, dual-wave transistor radio, with 'High-Q' Ferrite coils. £2.19.6.
UJR-1S Additional Amplifier Stage for this kit. 16.6.

HEATHKIT MODEL UXR-1 KIT

6-Transistor, Dual-Wave Portable.

The very attractive solid leather case of this elegantly styled portable radio set, and its exceptionally good performance, excite admiration everywhere. Its 7" × 4" high-flux speaker gives an unusually rich and clear reproduction, although the set is small and light enough to be carried anywhere. A High-Q Ferrite rod aerial gives good selectivity and sensitivity. Being completely self-contained this is an ideal second set for the home, and most economical to run; a 3/6 battery lasts about 6 months with average use. Not taking its power from the mains supply it is particularly safe in operation. The UXR-1 performs well in a car, too.

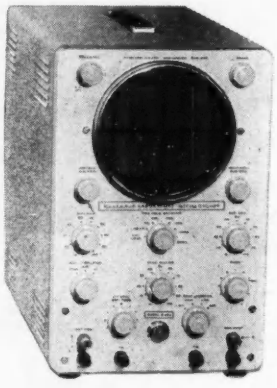
Printed-circuit board and pre-aligned I.F.T.'s permit assembly in 4 to 6 hours and you then have a delightful portable in the 25-30 guinea class.



MODEL UXR-1

£17 . 17 . 0 (inc. £5.11.0 P.T.)

Delivered free in U.K.
Deferred terms available



MODEL O-12U

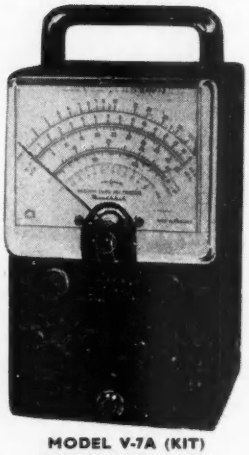
£34 . 15 . 0 Delivered free in U.K.

Assemble the Model O-12U 5" Oscillocope Kit and you'll have a large-screen laboratory instrument at utility 'scope price. Exceptionally wide-range time-base (10 c/s to over 500 kc/s. 'Y' frequency range 3 c/s to over 5 Mc/s, sensitivity 10 mV RMS/cm. 'X' sensitivity 0·12 V RMS/cm. Electronically stabilized and fused power supply. Output for Wobbulator. Voltage Calibrator (1 volt pk. to pk. source.) Instantaneous shift, drift free. Automatic lock-in synch. Rise time 0·08 μsecs or less. 'Z' modn. facilities. 2-gold-plated printed-circuit boards and pre-cut cabled wiring harness greatly facilitate assembly. Easy-to-follow 48-page Instruction Manual gives 'Step-by-Step' procedure. Ideal for Educational establishments, laboratories and service.
Deferred terms available

EVERY HEATHKIT MODEL WILL ACHIEVE OR BETTER ITS ADVERTISED PERFORMANCE, IF BUILT IN ACCORDANCE WITH THE INSTRUCTION MANUAL 'STEP-BY-STEP' PROCEDURE.

Because of the accuracy, reliability and sheer value of the Model V-7A it is outselling all other VVM's. The precision and quality of its first-class components cannot be duplicated elsewhere at this price. Indication is by a large 4½" 200 μA meter clearly calibrated for all ranges. The voltage divider uses 1% precison resistors. A gold-plated printed-circuit board simplifies the assembly, saves time and eliminates the possibility of wiring errors. It also ensures duplication of laboratory performance.

This multi-function VVM measures A.C. Volts (RMS and pk.-to-pk.), D.C. Volts and Resistance. The 7, A.C. (RMS) and D.C ranges are 1·5, 5, 15, 50, 150, 500 and 1500. The 7, A.C. pk.-to-pk. Voltage ranges are 0·4, 14, 40, 140, 400, 1400 and 4000. Input impedance is 11MΩ. Seven Ohm-meter ranges have multiplying factors of X1, X10, X100, X1000, X10K, X100K and X1MΩ. Centre-scale resistance readings are 10, 100, 1000, 10K Ohms, 1MΩ and 10MΩ. A centre-zero dB scale is provided also for measuring audio amplifier performance. Test leads, prods and battery are included in the kit.



MODEL V-7A (KIT) VALVE VOLTMETER

£13 . 0 . 0 Delivered free in U.K.

Deferred terms available

ENGINEERING EXECUTIVES: FOR MANY OF YOUR REQUIREMENTS IT WILL PAY YOU TO BUY HEATHKIT TEST INSTRUMENTS IN KIT FORM AND HAVE THEM ASSEMBLED BY YOUR JUNIOR ENGINEERS.

THE INSTRUCTION MANUAL FOR EACH KIT GIVES CLEAR 'STEP-BY-STEP' PROCEDURE FOR ITS ASSEMBLY, ALIGNMENT AND OPERATION.

ONLY FIRST-CLASS COMPONENTS, MATERIALS AND PROCESSING ARE USED THROUGHOUT.

Further information regarding any of these Heathkit models will gladly be sent on request.

ARE YOU ON OUR MAILING LIST?

DAYSTROM LTD. DEPT. EE4

GLOUCESTER, ENGLAND

A member of the Daystrom Group, manufacturers of
THE LARGEST-SELLING ELECTRONIC KITS IN THE WORLD

ELECTRO METHODS LTD OF STEVENAGE

BRITAIN'S FOREMOST DESIGNERS

AND MANUFACTURERS OF

PRECISION RELAYS

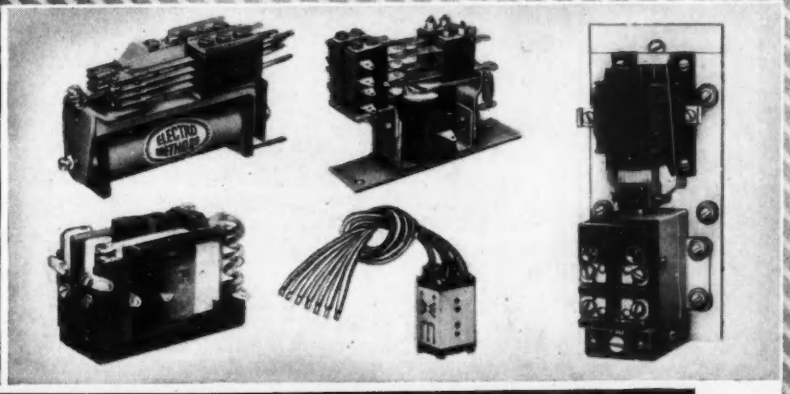
An extensive range
of our standard types of
Relays
is always available for
prompt delivery

*

SPECIAL TYPES CAN BE DESIGNED
TO SUIT YOUR NEEDS

*

Full technical data
and illustrated leaflets promptly
forwarded on request

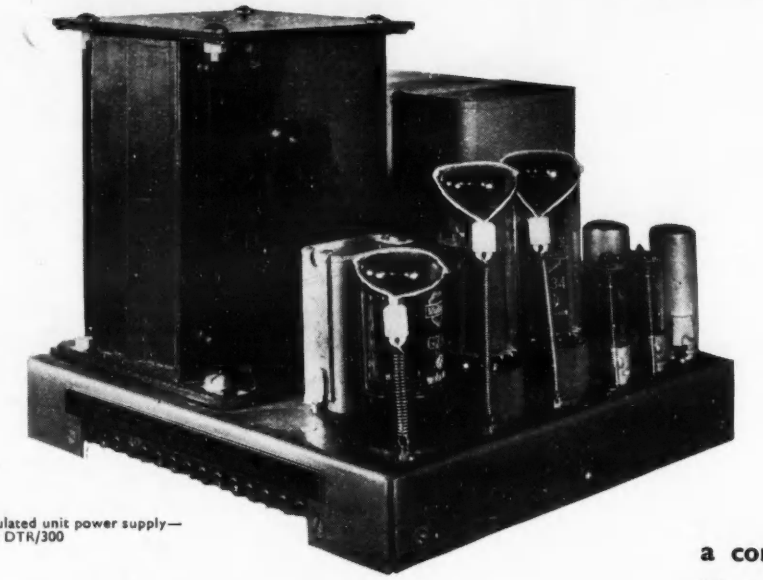


ELECTRO METHODS LTD. 17-41 CAXTON WAY, STEVENAGE, HERTS. Phone: STEVENAGE 2110-7

EE 8103 *for further details*

brandenburg high voltage engineering

a regulated unit power supply



Regulated unit power supply—
type DTR/300

for only £39.10.0 *ex works*

type DTR—3 models

output volts	350 V, nominal. Model 350 300 V, nominal. Model 300 250 V, nominal. Model 250 any two of these models may be used in series
output current	0-200 mA maximum
heater supply	two supplies at 6.3 volts, 3 amps each
polarity	reversible
effective resistance	0.1 ohm
stability	against + or − 10% mains change: 0.02%
ripple	less than 1 mV
input	100/125 volts—200/250 volts, 45/60 cycles
dimensions	9″ × 9″ × 7½″ high supplied with sturdy fixing brackets

a compact and finely engineered instrument at a remarkably low price

regulated D.C. power supplies by Brandenburg

contractors to the Ministry of Supply

Brochure on request For further details of the Brandenburg range of standard and specialized equipment, please write for brochure

BRANDENBURG LIMITED

139 Sanderstead Road, South Croydon, Surrey
SANderstead 3555/6

brandenburg high voltage engineering

10, 20 and 30 kilovolt regulated supply

type S0530/5, model C

output 1 to 10 kV at 2 mA. Model A
2 to 20 kV at 1 mA. Model B
3 to 30 kV at ½ mA. Model C
input 200/250 volts, 50 cycles
polarity positive or negative grounded available
regulation against full load: better than 0.5%
against mains variations: +5%,—10%. Better than 1%

- 5" Ernest Turner movement
- current metering jack
- standard 19" × 10½" P.O. panel
- for rack mounting or bench use
- as supplied to A.E.R.E. Harwell, I.C.I., B.B.C., Mullard Research Laboratories, R.R.E. Malvern, Pye Group, Marconi Instruments and Cavendish laboratories

£125 *ex works*

50 kilovolt regulated supply

Model S0550
output 50kV at ¼mA
input 200/250 volts
polarity positive or negative grounded available
regulation against full load: better than 1%
against mains variation: +5%,—5%. Better than 1%
dimensions W: 25½" H: 23" D: 11½"

£245 *ex works*

regulated D.C. power supplies by Brandenburg
contractors to the Ministry of Supply

Brochure on request For further details of the Brandenburg range of standard and specialized equipment please write for brochure

BRANDENBURG LIMITED
139 Sanderstead Road, South Croydon, Surrey
SANderstead 3555/6

EE 8104 *for further details*

"BROOMWADE" *presents*

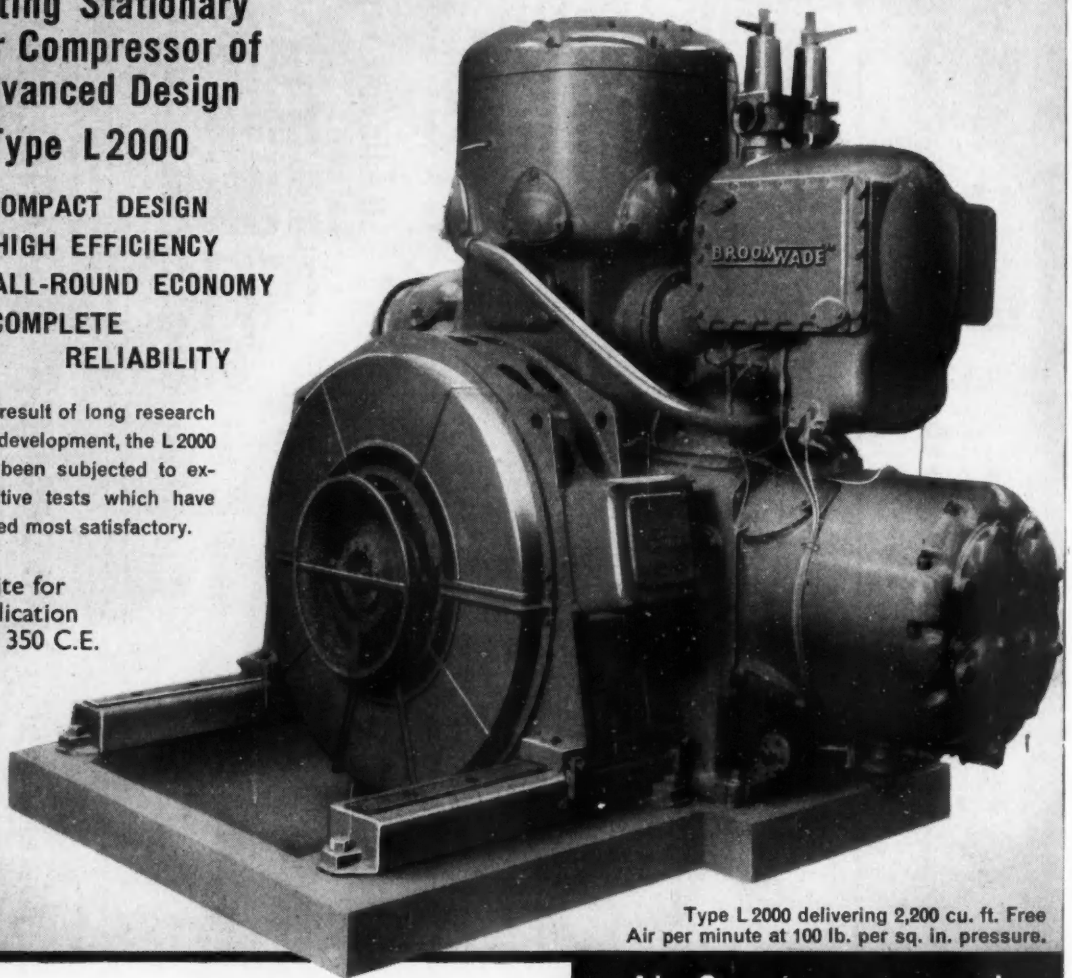
NEW Two-Stage Double-acting Stationary Air Compressor of Advanced Design

Type L2000

★ COMPACT DESIGN
★ HIGH EFFICIENCY
★ ALL-ROUND ECONOMY
★ COMPLETE RELIABILITY

The result of long research and development, the L2000 has been subjected to exhaustive tests which have proved most satisfactory.

Write for Publication No. 350 C.E.



Type L2000 delivering 2,200 cu. ft. Free Air per minute at 100 lb. per sq. in. pressure.

"BROOMWADE"

Air Compressors and Pneumatic Tools

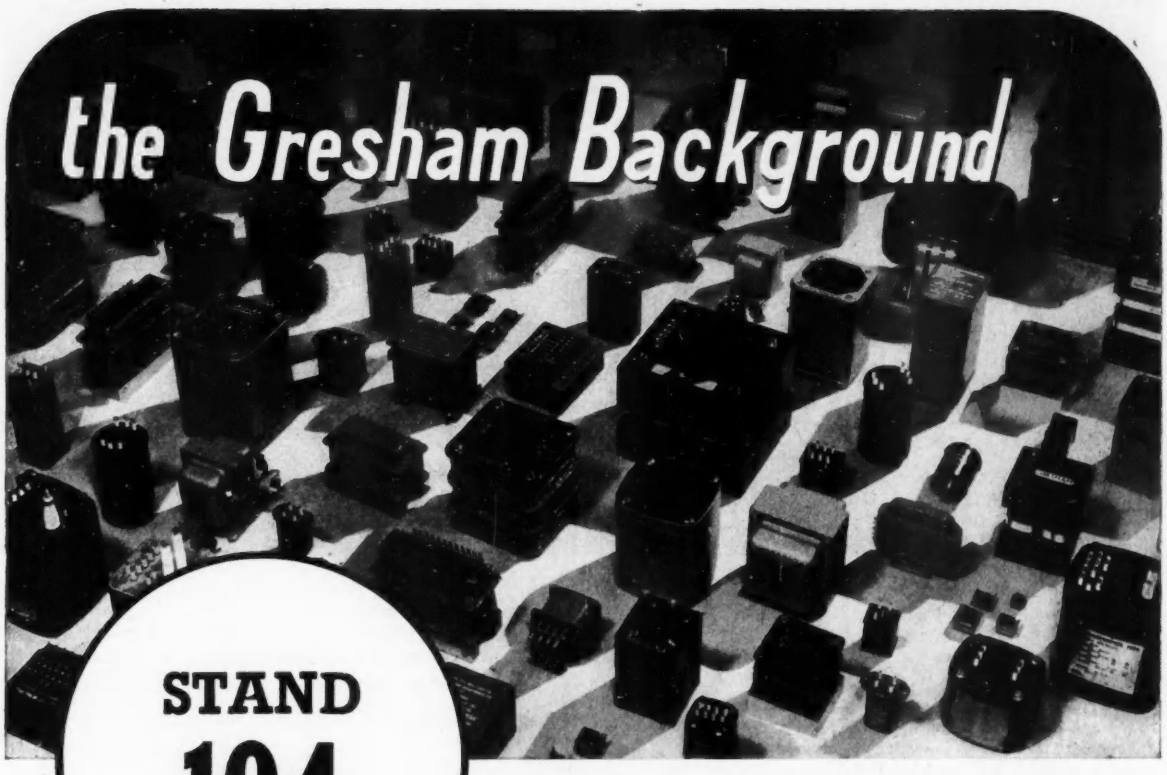
YOUR BEST INVESTMENT

BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND

Telephone: High Wycombe 1630 (10 lines). Telegrams: "Broom", High Wycombe. (Telex)

626 SAS

EE 8106 *for further details*



STAND 104

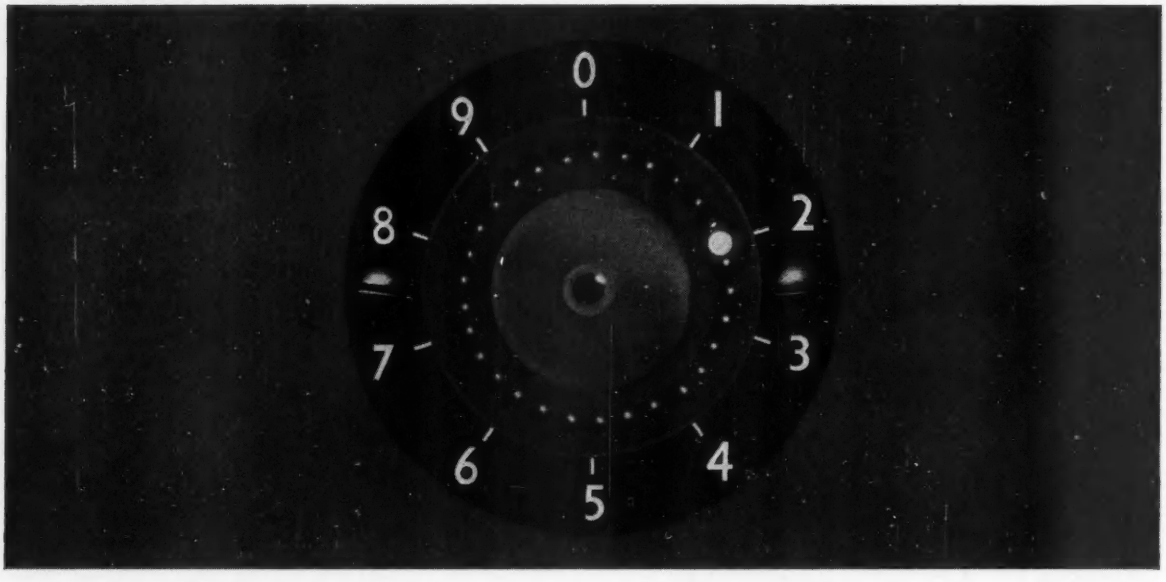
AT THE COMPONENT SHOW
GROSVENOR HOUSE, LONDON, April 6th-9th

On Stand 104 Gresham Transformers displays the most comprehensive range of transformers ever shown. In matters of weight, dimensions, temperature, performance, humidity resistance, or physical protection — there is hardly a problem which has not been solved by Gresham engineers. The fruits of this background of knowledge and experience can be seen in the many types which are interchangeable with the four ranged which have gained joint Service Approval to Humidity Class H.1. If you are unable to attend the Component Show, do not hesitate to telephone Feltham 6661 (or drop a line) for one of the Gresham transformer specialists to show you examples, and to suggest the best solution to your own transformer problem.

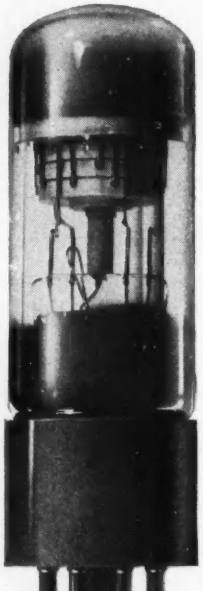
The constantly increasing demand for Gresham quality has created new opportunities for ambitious engineers—both senior and junior. There are immediate vacancies for these in the Work Study office and the Test department. If you are interested we will be glad to meet you on the Stand.

GRESHAM TRANSFORMERS LTD.
ELECTRONICS DIVISION

LION WORKS, HANWORTH ESTATE, FELTHAM, MIDDX.
Telephone: **FELTHAM 6661**



No interstage amplifier with this new Mullard counting tube **Z302C**

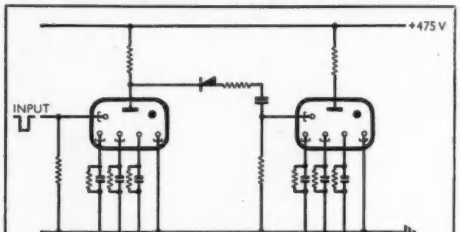


The new and unique Mullard cold cathode counting tube Z302C can be coupled *directly* to adjacent stages with consequent elimination of interstage amplifiers and many components.

This tube, which provides visual indication, operates with a single pulse drive. A typical circuit with two tubes in cascade is shown below.

Write today for details of the Z302C and other Mullard cold cathode decade tubes — Counting Tube Z303C (CV2271), Selector Tube Z502S (CV2325) and Indicator Tube Z503M.

TYPICAL BASIC CIRCUIT



Mullard

Mullard

GOVERNMENT AND INDUSTRIAL VALVE DIVISION

MULLARD LIMITED
MULLARD HOUSE
TORRINGTON PLACE
LONDON · W.C.1
Tel: Langham 6633

MVT334b

ELECTRONIC ENGINEERING

VOL. 31 No. 374

APRIL 1959

Commentary

THE Post Office Telephone service has received a great deal of publicity in the last year or so, and for two very different reasons. The first is the rapid strides which have recently taken place in the more complete mechanization of an already highly mechanized service; this is largely due to the introduction of electronic equipment, a notable example being the introduction of STD (Subscriber Trunk Dialling) at Bristol last December. The second reason is the Post Office's avowed intention to make this highly mechanized system more human: or in the words of the Postmaster General, 'It is to make sure that in a system where automatic machines will play an increasing part the customer can always get friendly personal service when he wants it'.

The first reason is obviously the prerogative of the engineer and, increasingly, the electronic engineer while the second, although non-technical is a matter which can, and should, be of interest to the engineer for, with any equipment which is intended for the usage of the public, the customer's convenience and the service which he obtains is of paramount importance. It is of little use for the engineer to evolve a complicated piece of equipment, or a system, if it fails to find ready acceptance by the intended user. It is largely to overcome these problems that the Post Office is to instigate this drive to make its services more personal.

The main inspiration for this 'humanizing' policy is the 'Ray' report ''Telephone Service and the Customer' which is the report of a team of Post Office officials and trade union representatives led by Mr. F. J. Ray, Director of Inland Telephone Communications, on a visit to America to study their telephone system. The team make it clear that in so short a visit (two weeks) they could not pretend to have gained more than a superficial impression of the system; nonetheless, there is a great deal of interest in the report and a great deal which could be beneficially applied on a far wider front than the telephone service.

The structure of the Bell Telephone System, is of course very different from that of the General Post Office. Heading the organization is the American Telephone and Telegraph Company which provides advice and assistance to the Bell Operating Companies of which there are twenty-two. In parallel with this is the Western Electric Company and the Bell Telephone Laboratories. The former carries out the manufacturing, purchasing, distributing and central office (telephone exchange) installation for the Bell System, while the latter carries out research and development work for the whole of the Bell System. While the A.T. & T. Co. does not exercise direct control over the individual companies, in the majority of cases it holds most, if not all, of their issued shares. It is, by any standards, a vast and up-to-date organization. At the end of 1957 the Bell System contained 52 000 000 telephone stations of which 92 per cent were connected to automatic exchanges. Of the total stations 28 per cent had some Direct Distance Dialling facilities (the American equivalent of STD), while 10 per cent could dial on a nationwide basis. The total staff engaged in operating the system is approximately 700 000 of whom 230 000 are telephone operating staff and supervisors.

The Ray report states that throughout this enormous structure there is one outstanding characteristic which underlies everything the System does; it is the desire to please the customer. And not only does the System plan to please the customer, it goes out of its way to help him to use the service he gets.

This desire to please starts right from the planning stage. When a particular line of development has been decided upon, at the earliest possible stage in the actual planning a substantial field trial is started, this is particularly so in the case of apparatus with which the customer will come into contact. Having obtained this direct evidence of customer reaction at an early stage in planning the System attaches great weight to it in coming to its final conclusions. When new types of apparatus or new facilities are finally introduced the Operating Companies go to great trouble to explain to the subscribers how they work and how they can obtain the utmost service from them.

This facet of the Bell System finds special scope in the repair service. Those who use this service are usually suffering from a sense of grievance and the Bell System aims at removing this feeling by the prompt and personal way in which fault report calls are handled as well as the speed with which the faults themselves are cleared.

By this desire and effort to please the customer the Bell Telephone System, according to the Ray report, has built up a great and enviable reputation and while much of this is far removed from engineering it points a lesson which can be learned with profit by all who design equipment or plan services for the use of others.

Linear Multi-Tapped Potentiometers with Loaded Outputs

By K. C. Garner*. B.Sc.(Eng.), A.M.I.E.E., A.F.R.Ae.S.

An analysis of multi-tapped linear potentiometers is given for the type where shunt resistors are connected between adjacent tapping points, and in the presence of an output load resistance.

Using the relationships of a generalized network with appropriate numerical substitutions obtained from the particular potentiometer arrangement being considered, evaluation is simple and systematic.

A procedure for designing potentiometers to generate non-linear functions is suggested.

(Voir page 247 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 253)

ONE of many ways of generating analogues of non-linear laws uses servo-driven linear potentiometers with fixed-valued shunt resistors connected across sections of their windings. The method is well known[1,2,3], but it is thought that a useful contribution to the technique would be to develop a systematic approach to the design of the networks; i.e. to the choice of shunt resistor values and tapping points. Considerable generalization is possible and although algebraically some of the relationships appear rather cumbersome, the method is quite simple and straightforward when used for design purposes, and numerical substitutions are inserted.

The analysis includes the practical consideration of the load across the potentiometer output. In fact the load resistance can often be turned to good effect to improve the accuracy of fit to the desired law.

The method used in this article is complementary to the diakoptic methods due to Kron and suggested by Shen[3]. and for most purposes will prove equally direct for the restricted type of network considered.

The Four Basic Cases

Fig. 1 shows the typical circuit of a multi-tapped potentiometer of resistance R, having $m-1$ tappings at distances $n_1, n_2, \ldots, n_m$, and with fixed valued resistors $R_1, R_2, \ldots, R_m$ connected between them. The wiper is at a distance K from the 'earthy' end, where K can vary between zero and unity. The input voltage is V_1 and the output voltage is V_o. The output load resistance is defined as R_L.

As K increases from zero to unity an equivalent network can be drawn each time the wiper crosses a tapping point and traverses a particular section of the potentiometer. These equivalent networks fall into three fundamental cases as illustrated by Fig. 2(a), (b) and (d). A fourth case, shown in Fig. 3(a), is applicable if a shunt resistor has been omitted and the wiper traverses this un-shunted section.

CASE 1 (*where* $0 \leqslant K \leqslant n_1$)

In this case, illustrated by Fig. 2(a), the portion of the potentiometer between the input and the tapping point at n_1 consists of the sum of all the paralleled resistances and sections of the potentiometer winding involved.

CASE 2 (*where* $n_1 + n_2 + \ldots + n_{x-1} \leqslant K \leqslant n_1 + n_2 \ldots + n_x$ *and where* $2 \leqslant x \leqslant m-1$).

Fig. 2(b) shows the circuit for Case 2 where the wiper is traversing any section, except for the section connected directly to earth or the section connected directly to the input end.

This circuit can be drawn in an alternative bridge network form as in Fig. 2(c) where

R_a = Sum of the paralleled resistances for values of n_p where $m > p > x$

$R_b = [(n_1 + n_2 \ldots + n_x) - K]\,R$

$R_c = R_L$

R_d = Sum of the paralleled resistances for values of n_q where $0 < q \leqslant (x-1)$

$R_e = R_x$

$R_f = [K - (n_1 + n_2 \ldots + n_{x-1})]\,R$

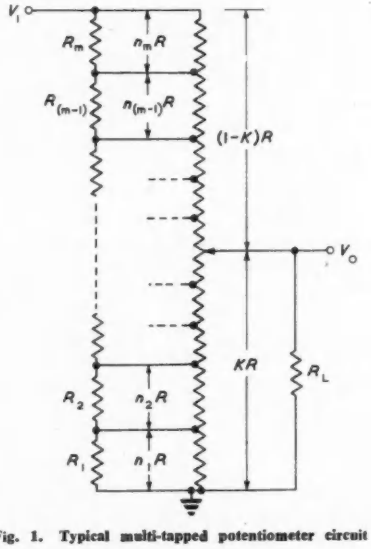


Fig. 1. Typical multi-tapped potentiometer circuit

CASE 3 (*where* $n_1 + n_2 + \ldots + n_{m-1} \leqslant K \leqslant 1$)

This circuit is given in Fig. 2(d) and as in Case 2 the alternative bridge network form of the circuit is shown in Fig. 2(e).

CASE 4 (*Wiper traversing an un-shunted section*)

If one or more fixed-valued shunt resistors are omitted between tappings a fourth case emerges when the wiper traverses such sections. Fig. 3(a) shows a typical example of this case, and Fig. 3(b) the equivalent circuit.

The Generalized Network

From further consideration of the circuits it appears that the network of Case 2 is in fact the generalized network, since it is possible to derive cases 1, 3 and 4 from it by

* *The College of Aeronautics, Cranfield.*

making certain resistances zero or infinite. Thus case 1 may be obtained by considering $R_d = 0$. Case 3 is obtained by letting R_a vanish, and Case 4 by making $R_e = \infty$.

This approach to the problem enables one general equation, representing the attenuation of the bridge network of Fig. 2(c) to be used for all cases. By compiling the appropriate set of substitutions for each section (which are unique for the section being traversed by the wiper), the complete law of the multi-tapped potentiometer may be calculated.

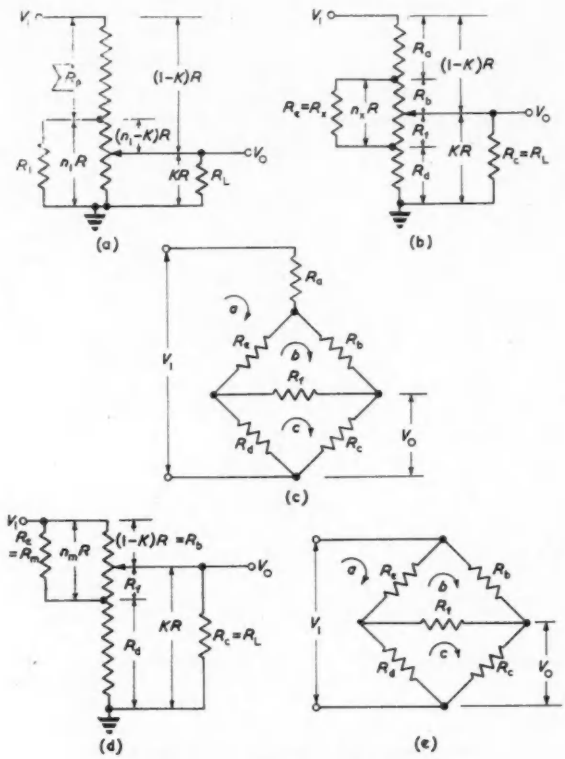


Fig. 2 (a). Equivalent circuit for Case 1

$$\sum Rp = \left\{ \begin{array}{c} \text{Sum of paralleled resistors from} \\ x=2 \text{ to } x=m \text{ where } m = \text{total number} \\ \text{of shunt resistors} \end{array} \right\} = \sum_{x=2}^{x=m} \frac{n_x R R_x}{(n_x R + R_x)}$$

(b) Equivalent circuit for Case 2
(c) Bridge form of the network of Fig. 2(b) (Case 2)
(d) Equivalent circuit for Case 3

R_d Sum of paralleled resistors for n_q where
$0 < q \leqslant m-1$
$R_f = [K-(n_1+n_2 \ldots +n_{(m-1)})]\,R$

(e) Bridge form of Case 3

Analysis of the Generalized Network

The generalized network is shown in Fig. 2(c). Let the circulating currents a, b, and c be positive in the sense denoted by the arrows.

By inspection of the figure

$$b(R_b + R_f + R_e) = aR_e + cR_f = bZ_1 \quad \ldots\ldots\ (1)$$

$$c(R_e + R_d + R_f) = aR_d + bR_f = cZ_2 \quad \ldots\ldots\ (2)$$

and

$$V_1 = a(R_a + R_e + R_d) - cR_d - bR_e \quad \ldots\ldots\ (3)$$

or

$$V_1 = aZ_3 - cR_d - bR_e \quad \ldots\ldots\ (4)$$

from which

$$a = \frac{c(Z_1Z_2 - R_f^2)}{(Z_1R_d + R_eR_f)} \quad \ldots\ldots\ (5)$$

$$b = \frac{c(Z_2R_e + R_dR_f)}{(Z_1R_d + R_eR_f)} \quad \ldots\ldots\ (6)$$

Putting these values for a and b in equation (4) and rearranging it is found that

$$c = \frac{(Z_1R_d - R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)} V_1 \quad \ldots\ (7)$$

and remembering that the output load is represented by R_e one can write

$$V_o/V_1 = cR_e/V_1 \quad \ldots\ldots\ (8)$$

so that the general equation is*

$$V_o/V_1 = \frac{R_e(Z_1R_d + R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)} \quad (9)$$

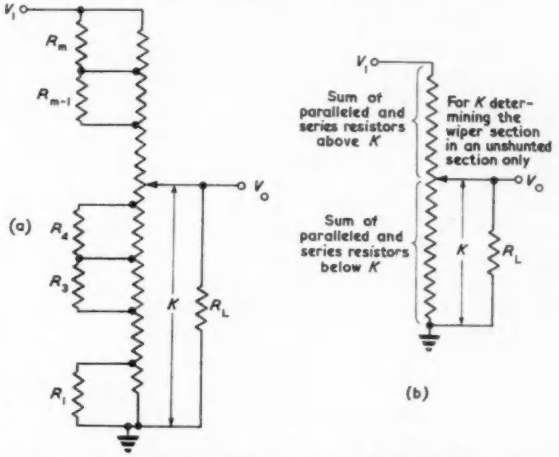

(a)
(b)
Sum of paralleled and series resistors above K
For K determining the wiper section in an unshunted section only
Sum of paralleled and series resistors below K

Fig. 3(a). Potentiometer network with resistors omitted between tappings (Case 4) (when wiper traverses an unshunted section)
(b) Equivalent circuit for Case 4

where $Z_1 = (R_b + R_f + R_e) \quad \ldots\ldots\ (10)$

$Z_2 = (R_e + R_d + R_f) \quad \ldots\ldots\ (11)$

$Z_3 = (R_a + R_e + R_d) \quad \ldots\ldots\ (12)$

Analysis of Each of the Four Cases

Case 1 ($0 \leqslant K \leqslant n_1$)

As stated above, Case 1 is obtained by making R_d vanish in equation (9) with the result that the equation then represents the network of Fig. 2(a) with the appropriate values substituted. Thus the characteristic is given by

$$V_o/V_1 = \frac{R_e(Z_1R_d + R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)} \quad (13)$$

where

$$Z_1 = (R_b + R_f + R_e) = (n_1 - K)R + KR + R_1 = (n_1R + R_1) \quad \ldots\ldots\ (14)$$

$$Z_2 = (R_e + R_d + R_f) = (R_L + KR) \quad \ldots\ldots\ (15)$$

$$Z_3 = (R_a + R_e + R_d) = (\sum R_p + R_1) \quad \ldots\ldots\ (16)$$

$R_a = \sum R_p =$ Sum of paralleled resistances above tapping at n_1 (i.e. for values of n_p where $m \geqslant p > 1$) $\quad \ldots\ldots\ (17)$

The expression in this form exhibits certain redundancies apparent from the minus signs and squared terms. It is, however, considered to be in the easiest form to memorize.

$$R_b = (n_1 - K)\,R \quad \ldots\ldots (18)$$

$$R_c = R_L \quad \ldots\ldots (19)$$

$$R_d = 0 \quad \ldots\ldots (20)$$

$$R_e = R_1 \quad \ldots\ldots (21)$$

$$R_f = KR \quad \ldots\ldots (22)$$

CASE 2 ($n_1 + n_2 + \ldots + n_{x-1} \leqslant K \leqslant n_1 + n_2 + \ldots + n_x$) and where ($2 \leqslant x \leqslant m - 1$)

This case has been illustrated in Fig. 2(b), but for the purposes of analysis it is preferable to consider Fig. 2(c). The relationship already obtained is

$$V_o/V_1 = \frac{R_c(Z_1R_d + R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)} \quad (23)$$

with the following substitutions

R_a = Sum of the paralleled resistances for values of n_p where $m \geqslant p > x$ ..... (24)

$$R_b = [(n_1 + n_2 + \ldots + n_x) - K]\,R \quad \ldots\ldots (25)$$

$$R_c = R_L \quad \ldots\ldots (26)$$

R_d = Sum of the paralleled resistances for values of n_q where $0 < q \leqslant (x - 1)$ ..... (27)

$$R_e = R_x \quad \ldots\ldots (28)$$

$$R_f = [K - (n_1 + n_2 + \ldots + n_{x-1})]\,R \quad \ldots\ldots (29)$$

and $Z_1 = (R_b + R_f + R_e)$ ..... (30)

$$Z_2 = (R_c + R_d + R_f) \quad \ldots\ldots (31)$$

$$Z_3 = (R_a + R_e + R_d) \quad \ldots\ldots (32)$$

CASE 3 ($n_1 + n_2 + \ldots + n_{m-1} \leqslant K \leqslant 1$)

Case 3 is given in Fig. 2(d) and the bridge form shown in Fig. 2(e). Again the network attenuation is obtained using the generalized equation

$$V_o/V_1 = \frac{R_c(Z_1R_d + R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)}. \quad (33)$$

but with the following substitutions in this case:

$$R_a = 0 \quad \ldots\ldots (34)$$

$$R_b = (1 - K)\,R \quad \ldots\ldots (35)$$

$$R_c = R_L \quad \ldots\ldots (36)$$

R_d = Sum of the paralleled resistances for values of n_q where $0 < q \leqslant (m - 1)$ ..... (37)

$$R_e = R_m \quad \ldots\ldots (38)$$

$$R_f = [K - (n_1 + n_2 + \ldots + n_{m-1})]\,R \quad \ldots\ldots (39)$$

and $Z_1 = (R_b + R_f + R_e)$ ..... (40)

$$Z_2 = (R_c + R_d + R_f) \quad \ldots\ldots (41)$$

$$Z_3 = (R_a + R_e + R_d) \quad \ldots\ldots (42)$$

CASE 4 (*when shunt resistors are omitted between tappings, and the wiper is traversing an un-shunted section*)

Fig. 3(b) illustrates this case, and it is evident that the same general equation holds good provided that $R_e = \infty$. Thus

$$V_o/V_1 = \frac{R_c(Z_1R_d + R_eR_f)}{(Z_1Z_2Z_3 - Z_1R_d^2 - Z_2R_e^2 - Z_3R_f^2 - 2R_dR_eR_f)}. \quad (43)$$

where

$$Z_1 = (R_b + R_e + R_f) \quad \ldots\ldots (44)$$

$$Z_2 = (R_c + R_d + R_f) \quad \ldots\ldots (45)$$

$$Z_3 = (R_a + R_d + R_e) \quad \ldots\ldots (46)$$

and $R_c = \infty$

so that neglecting all terms except those containing R_e

$$V_o/V_1 = \frac{(R_d + R_f)R_cR_e}{(R_a + R_b)(R_c + R_d + R_f)\,R_e + (R_d + R_f)R_cR_e}. \quad (47)$$

or

$$V_o/V_1 = \frac{(R_d + R_f)R_c}{(R_a + R_b)(R_c + R_d + R_f) + (R_d + R_f)\,R_c} \quad \ldots (48)$$

where

R_a = Sum of the paralleled and series resistances for values of n_p where $m \geqslant p > x$ ..... (49)

$$R_b = [(n_1 + n_2 + \ldots + n_x) - K]\,R \quad \ldots\ldots (50)$$

$$R_c = R_L \quad \ldots\ldots (51)$$

R_d = Sum of the paralleled and series resistances for values of n_q where $0 < q \leqslant (x - 1)$ .... (52)

$$R_f = [K - (n_1 + n_2 + \ldots + n_{x-1})]\,R \quad \ldots\ldots (53)$$

The Application of the Analysis to Typical Networks

From the relationships derived so far, all the arrangements of multi-tapped potentiometers of the type shown in Fig. 1 can be evaluated by choosing suitable values for

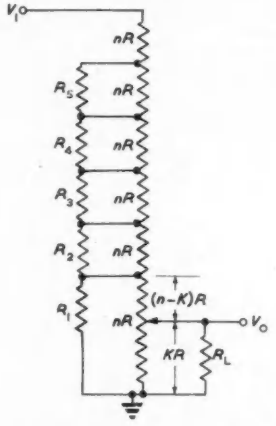


Fig. 4. A multi-tapped potentiometer with an output load (Case 1)

R_a, R_b, R_c, R_d, R_e and R_f. In the more simple arrangements considered later it is probably more convenient, analytically, to derive the characteristic from first principles. However, when direct numerical substitutions are made in the generalized equation the calculation is quite simple.

A MULTI-TAPPED POTENTIOMETER WITH AN OUTPUT LOAD

To illustrate this example a potentiometer has been chosen having five tapping points spaced at equal distances, n, along the winding. These tapping points are numbered in such a way that the first is at a distance n from the 'earthy' terminal, and the fifth is at a distance n from the input terminal. These tapping points are connected by resistors R_1, R_2, R_3, R_4 and R_5. There is no resistor between the fifth tapping point and the input terminal.

Fig. 4 shows the potentiometer with an output load R_L, and with the wiper in the first section under the condition $0 \leqslant K \leqslant n$, so that the resulting network is an example of Case 1 and the substitution values are:

$$R_a = \frac{nRR_2}{(nR + R_2)} + \frac{nRR_3}{(nR + R_3)} + \frac{nRR_4}{(nR + R_4)} + \frac{nRR_5}{(nR + R_5)} + nR \quad \ldots (54)$$

$$= nR\left[\frac{1}{(n\rho_2 + 1)} + \frac{1}{(n\rho_3 + 1)} + \frac{1}{(n\rho_4 + 1)} + \frac{1}{(n\rho_5 + 1)} + 1\right] \quad \ldots\ldots (55)$$

and letting such terms as $\frac{1}{n\rho_x + 1}$ be represented by γ_x then

$$R_a = nR(\gamma_2 + \gamma_3 + \gamma_4 + \gamma_5 + 1) \quad \ldots\ldots (56)$$

$$R_b = (n - K)R \quad \ldots\ldots (57)$$

$$R_c = R_L \quad \ldots\ldots (58)$$

$$R_d = 0 \quad \ldots\ldots (59)$$

$$R_e = R_1 \quad \ldots\ldots (60)$$

$$R_f = KR \quad \ldots\ldots (61)$$

so that for $(0 \leqslant K \leqslant n)$..

$$V_o/V_1 = \frac{K\gamma_1}{n(1+\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)(1+K\rho_L-\overline{K^2}\rho_L\rho_1\gamma_1)-\overline{K^2}\rho_L\gamma_1^2} \quad (62)$$

The case when $\rho_L = 0$ is given by

$$V_o/V_1 \text{ (no load)} = \frac{K\gamma_1}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots\ldots (63)$$

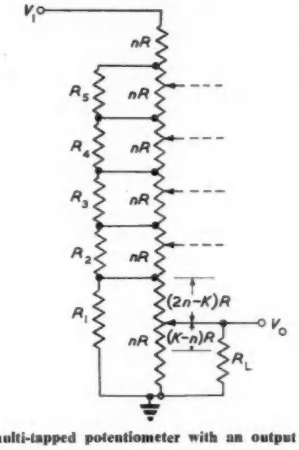


Fig. 5. A multi-tapped potentiometer with an output load (Case 2)

The voltage when the wiper is on the first tapping point is given by

$$V_o/V_1 \text{ (for } K = n) = \frac{1}{(\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)(n\rho_1+n\rho_L+1)+1} \quad \ldots\ldots (64)$$

and

$$V_o/V_1 \text{ (no load and } K = n) = \frac{\gamma_1}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad (65)$$

When the wiper traverses $(n \leqslant K \leqslant 2n)$, $(2n \leqslant K \leqslant 3n)$, $(3n \leqslant K \leqslant 4n)$, $(4n \leqslant K \leqslant 5n)$, the networks formed in each condition are examples of Case 2. A set of substitutions are obtained from Fig. 5 to form the equation for each mode of operation and are listed in Table 1.

TABLE 1

RESISTANCE NOTATION	$n \leqslant K \leqslant 2n$	$2n \leqslant K \leqslant 3n$	$3n \leqslant K \leqslant 4n$	$4n \leqslant K \leqslant 5n$
Ra	$nR(1+\gamma_5+\gamma_4+\gamma_3)$	$nR(1+\gamma_5+\gamma_4)$	$nR(1+\gamma_5)$	nR
Rb	$(2n-K)R$	$(3n-K)R$	$(4n-K)R$	$(5n-K)R$
Rc	R_L	R_L	R_L	R_L
Rd	$nR\gamma_1$	$nR(\gamma_1+\gamma_2)$	$nR(\gamma_1+\gamma_2+\gamma_3)$	$nR(\gamma_1+\gamma_2+\gamma_3+\gamma_4)$
Re	R_2	R_3	R_4	R_5
Rf	$(K-n)R$	$(K-2n)R$	$(K-3n)R$	$(K-4n)R$

If these substitutions are given their numerical values the attenuation characteristic can be calculated for the condition when there is an output load. When designing a non-linear function generator, however, the most useful expressions, in the first instance, are those giving the no-load condition. These can be obtained by using the above substitutions and making $R_c = R_L = 0$, so that

For $(n \leqslant K \leqslant 2n)$

$$V_o/V_1 \text{ (no load)} = \frac{(K-n)\gamma_2+n\gamma_1}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots\ldots (66)$$

For $(2n \leqslant K \leqslant 3n)$

$$V_o/V_1 \text{ (no load)} = \frac{(K-2n)\gamma_3+n(\gamma_1+\gamma_2)}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots\ldots (67)$$

For $(3n \leqslant K \leqslant 4n)$

$$V_o/V_1 \text{ (no load)} = \frac{(K-3n)\gamma_4+n(\gamma_1+\gamma_2+\gamma_3)}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots\ldots (68)$$

For $(4n \leqslant K \leqslant 5n)$

$$V_o/V_1 \text{ (no load)} = \frac{(K-4n)\gamma_5+n(\gamma_1+\gamma_2+\gamma_3+\gamma_4)}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad (69)$$

and hence the voltage on the wiper when in contact with the

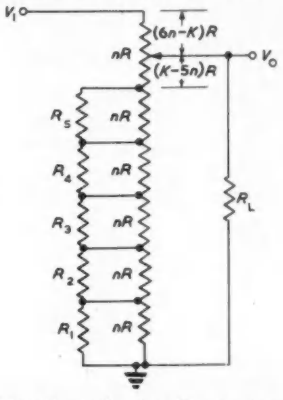


Fig. 6. A multi-tapped potentiometer with an output load (Case 4)

various tappings points in the absence of the load resistance is

$$V_o/V_1 \text{ (no load, } K = n) = \frac{\gamma_1}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots 70)$$

$$V_o/V_1 \text{ (no load, } K = 2n) = \frac{(\gamma_1+\gamma_2)}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots (71)$$

$$V_o/V_1 \text{ (no load, } K = 3n) = \frac{(\gamma_1+\gamma_2+\gamma_3)}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots (72)$$

$$V_o/V_1 \text{ (no load, } K = 4n) = \frac{(\gamma_1+\gamma_2+\gamma_3+\gamma_4)}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots (73)$$

$$V_o/V_1 \text{ (no load, } K = 5n) = \frac{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)}{(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad \ldots (74)$$

When the wiper moves in the section $5n \leqslant K \leqslant 1$ the network becomes an example of Case 4 and the following substitutions obtained from Fig. 6 are used:—

$$R_a = 0 \quad \ldots\ldots (75)$$

$$R_b = (6n - K)R \quad \ldots\ldots (76)$$

$$R_c = R_L \quad \ldots\ldots (77)$$

$$R_d = nR(\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5) \quad \ldots\ldots (78)$$

$$R_e = \infty \quad \ldots\ldots (79)$$

$$R_f = (K - 5n)R \quad \ldots\ldots (80)$$

With these values the following relationship is obtained:

$$V_o/V_1 = \frac{(K-5n)+n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)}{(6n-K)[(K-5n)\rho_L+n\rho_L(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)+1]+(K-5n)+n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)} \quad \ldots (81)$$

and the value for no load, (i.e. $\rho_L = 0$) is

$$V_o/V_1 \text{ (no load)} = \frac{(K-5n)+n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5)}{n(\gamma_1+\gamma_2+\gamma_3+\gamma_4+\gamma_5+1)} \quad (82)$$

The Simple Linear Potentiometer with an Output Load

This circuit is included for the sake of completeness, and for the importance of the result in determining the loading error of linear servo multipliers. The circuit is shown in Fig. 7. Since it represents the case of a completely un-shunted 'multi-tapped' potentiometer it can be considered as an example of Case 4.

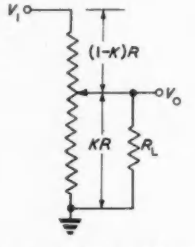


Fig. 7. Linear potentiometer with output load

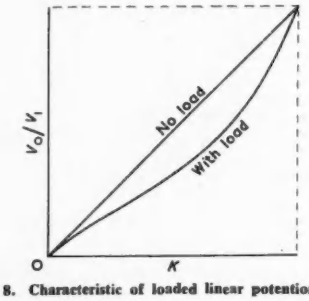


Fig. 8. Characteristic of loaded linear potentiometer

The substitutions for this network are

$$R_a = 0 \quad (83)$$
$$R_b = (1-K)R \quad (84)$$
$$R_c = R_L \quad (85)$$
$$R_d = 0 \quad (86)$$
$$R_e = \infty \quad (87)$$
$$R_f = KR \quad (88)$$

so that

$$V_o/V_1 = \frac{KRR_L}{(1-K)R(R_L+KR)+KRR_L} \quad (89)$$

or

$$V_o/V_1 = \frac{K}{1+K\rho_L(1-K)} \quad (90)$$

i.e. the law of a practical servo-driven multiplying potentiometer, where $\rho_L = (R/R_L)$

In the absence of the load resistance R_L, $\rho_L = 0$ so that

$$V_o/V_1 \text{ (no load)} = K \quad (91)$$

i.e. an ideal servo-driven multiplying potentiometer.

Fig. 8 shows a typical characteristic curve for this network.

The Single-Tapped Potentiometer with an Output Load

Some non-linear functions can be generated to an acceptable accuracy using a standard centre-tapped loaded linear potentiometer and the following results are applicable for networks derived this way.

There are two variations of this circuit:

(a) Type 1, when the shunt resistor is taken to the "earthy" end.

(b) Type 2, when the shunt resistor is taken to the input end.

A third type is possible where there are two shunt resistors, but this can be resolved into networks of the forms of Cases 2 and 3.

Type 1.

The circuit for Type 1 is shown in Fig. 9 (a) and (b). Fig. 9(a) represents the condition for Case 1 ($0 \leqslant K \leqslant n$), and Fig. 9(b) that for Case 4 ($n \leqslant K \leqslant 1$). The circuit is such that the shunt resistor R_1 is connected between the tapping point and earth, and a load resistance R_L is connected between the wiper and earth.

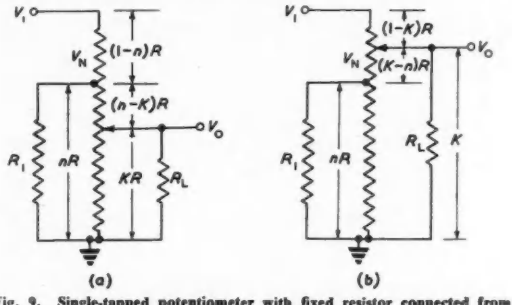


Fig. 9. Single-tapped potentiometer with fixed resistor connected from tapping to earth with an output load (Type 1)
(a) Case 1; (b) Case 4

For Case 1 ($0 \leqslant K \leqslant n$) the following substitutions are obtained by inspection of the Fig. 9(a):

$$R_a = (1-n)R \quad (92)$$
$$R_b = (n-K)R \quad (93)$$
$$R_c = R_L \quad (94)$$
$$R_d = 0 \quad (95)$$
$$R_e = R_1 \quad (96)$$
$$R_f = KR \quad (97)$$

and by substituting these values into the generalized equation

$$V_o/V_1 = \frac{KRR_LR_1}{(nR+R_1)(KR+R_L)[(1-n)R+R_1]-[(1-n)R+R_1]K^2R^2-(KR+R_L)R_1^2} \quad (98)$$

$$= \frac{K}{Kn\rho_1\rho_L - Kn^2\rho_1\rho_L + n\rho_1 - n^2\rho_1 + K\rho_L + 1 - K^2\rho_1\rho_L + K^2n\rho_1\rho_L - K^2\rho_L} \quad (99)$$

or alternatively by rearranging

$$V_o/V_1 = \frac{K}{1+K\rho_L(1-K)+\rho_1(1-n)[n+K\rho_L(n-K)]} \quad (100)$$

where $\rho_1 = (R/R_1)$ and $\rho_L = (R/R_L)$

For the no-load condition $\rho_L = 0$ so that

$$V_o/V_1 \text{ (no load)} = \frac{K}{1+n\rho_1(1-n)} \quad (101)$$

For Case 4 ($n \leqslant K \leqslant 1$) a similar set of substitutions are obtained from Fig. 9(b) so that

$$R_a = 0 \quad (102)$$
$$R_b = (1-K)R \quad (103)$$
$$R_c = R_L \quad (104)$$
$$R_d = \frac{NRR_1}{(nR+R_1)} \quad (105)$$
$$R_e = \infty \quad (106)$$
$$R_f = (K-n)R \quad (107)$$

and since $R_e = \infty$, these values may be substituted in equation (48)

Thus

$$V_o/V_1 = \frac{\left[\frac{nRR_1}{(nR + R_1)} + (K - n)R\right]R_L}{(1 - K)R\left[\frac{nRR_1}{(nR + R_1)} + (K-n)R + R_L\right] + \left[\frac{nRR_1}{(nR + R_1)} + (K - n)R\right]R_L} \quad \ldots (108)$$

or

$$V_o/V_1 = \frac{K}{1 + K\rho_L(1 - K) + \frac{n^2\rho_1(1 - K)}{n\rho_1(K - n) + K}} \quad \ldots (109)$$

where $\rho_1 = (R/R_1)$ and $\rho_L = (R/R_L)$

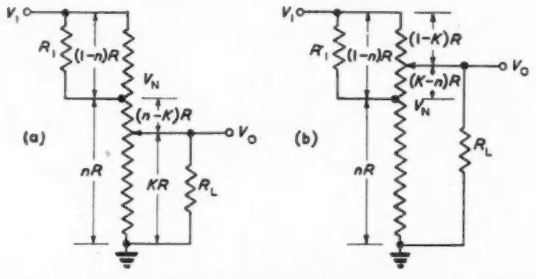


Fig. 10. Single-tapped potentiometer with fixed resistor connected from tapping to input with an output load (Type 2)
(a) Case 4; (b) Case 2

For the no-load condition $\rho_L = 0$, so that

$$V_o/V_1 \text{ (no load)} = \frac{K + n\rho_1(K - n)}{1 + n\rho_1(1 - n)} \quad \ldots (110)$$

Type 2

Fig. 10(a) shows the circuit condition when $0 \leqslant K \leqslant n$, and is again an example of Case 4 since the wiper is traversing an un-shunted section. Therefore the following substitutions into equation (48) are made:

$$R_a = \frac{(1 - n)RR_1}{(1 - n)R + R_1} \quad \ldots (111)$$

$$R_b = (n - K)R \quad \ldots (112)$$

$$R_c = R_L \quad \ldots (113)$$

$$R_d = 0 \quad \ldots (114)$$

$$R_e = \infty \quad \ldots (115)$$

$$R_f = KR \quad \ldots (116)$$

so that

$$V_o/V_1 = \frac{KRR_L}{\left[\frac{(1-n)RR_1}{(1-n)R + R_1} + (n-K)R\right](KR + R_L) + KRR_L} \quad \ldots (117)$$

or

$$V_o/V_1 = \frac{K}{\left[\frac{(1-n)}{(1-n)\rho_1 + 1} + (n-K)\right](K\rho_L + 1) + K} \quad \ldots (118)$$

where $\rho_1 = (R/R_1)$ and $\rho_L = (R/R_L)$

For the no load condition when $\rho_L = 0$

$$V_o/V_1 \text{ (no load)} = \frac{K[1 + \rho_1(1-n)]}{1 + n\rho_1(1 - n)} \quad \ldots (119)$$

For the attenuation when $n \leqslant K \leqslant 1$, illustrated by Fig. 10(b) the substitutions are as follows:

$$R_a = 0 \quad \ldots (120)$$

$$R_b = (1 - K)R \quad \ldots (121)$$

$$R_c = R_L \quad \ldots (122)$$

$$R_d = nR \quad \ldots (123)$$

$$R_e = R_1 \quad \ldots (124)$$

$$R_f = (K - n)R \quad \ldots (125)$$

which gives

$$V_o/V_1 = \frac{[nR(1-n) + KR_1]R_L}{[nR(1-n)+KR_1]R_L + [K(1-K+n)-n]nR^2 + KRR_1(1-K)} \quad \ldots (126)$$

or

$$V_o/V_1 = \frac{[n\rho_1(1-n) + K]}{[n\rho_1(1-n)+1] + n\rho_1\rho_L[K(1-K+n)-n] + K\rho_L(1-K)} \quad \ldots (127)$$

and the no-load condition when $\rho_L = 0$ is

$$V_o/V_1 \text{ (no load)} = \frac{K + n\rho_1(1 - n)}{1 + n\rho_1(1 - n)} \quad \ldots (128)$$

Suggested Design Procedure when applied to the Generation of Non-Linear Functions

Using the analytical methods contained in this note, it is possible to design tapped-potentiometer networks to approximate many monotonic functions (e.g. secant law, logarithmic law, parabolic law, etc.). Basically, the problem resolves itself into determining,

(1) The number of tapping points which are necessary to ensure that the required accuracy is obtained.

(2) The values required for the shunt resistors.

(3) The best value for the output load, if this is controllable.

A possible procedure is outlined below.

Design Procedure

Given the non-linear law, either in graphical form or as a mathematical expression, the first step would be to estimate the number of tapping-points necessary to obtain the desired accuracy. This may be done by postulating a trial number of tapping points at known spacings and assuming that the voltages at the tapping-points can be made to lie on the non-linear function curve, in the absence of an output load. With the assumption that $R_L = \infty$, the slope of V_o/V_1 between tappings will be constant, so that by joining the tapping-points as they occur on the non-linear law curve, with straight lines, as in Fig. 11, the no-load curve of the potentiometer network may be drawn. From this curve the maximum error is readily determined. If this maximum error exceeds the permissible tolerance the number of tapping-points should be increased and/or the spacings decreased over parts of the non-linear curve where the radius of curvature is small. In practice the spacing can usually be made equal, provided enough tapping-points can be made available, with consequent simplification of the design calculations which are to follow.

Because generalization is difficult it will be assumed that, on the basis of the above criterion, a satisfactory result

will be obtained by using the number of tapping-points at the spacings shown in the potentiometer network of Fig. 4, i.e. five tapping points each at equal distances apart. The next step is to determine the shunt resistor values which will satisfy the condition that the voltages at the tapping points, in the absence of an output load, will lie on the non-linear function curve. Such values will quite possibly be satisfactory for the final design in the presence of an output load, and will be of the right order.

Let the non-linear law be

$$x = Cf_1(\beta) \quad \ldots\ldots\ldots\ldots\ldots (129)$$

or expressed as voltage analogues

$$V_o = V_1 f_1(K) \quad \ldots\ldots\ldots\ldots\ldots (130)$$

Since it has been assumed that the potentiometer-network of Fig. 4 is to be the basic network for the design, the

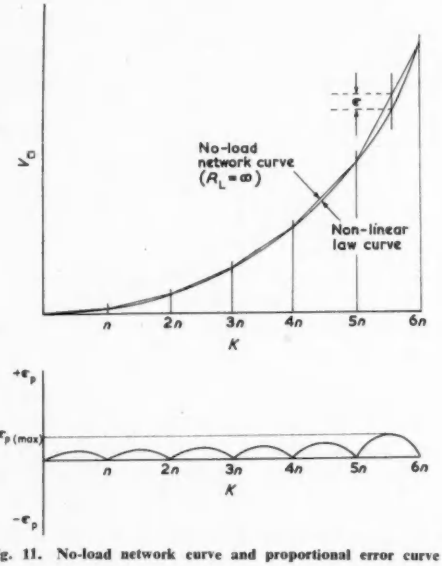


Fig. 11. No-load network curve and proportional error curve

values of the shunt resistors can be obtained by solving for R_1, R_2, R_3, R_4, and R_5 from equations (70) to (74) where V_o/V_1 (no load, $K = n$ to $5n$) $= (V_{N1\text{-}5}/V_1) = a_1$ to a_5 .. (131)

a_1 to a_5 being ratios derived from the law

$$V_o = V_1 f_1(K) \quad \ldots\ldots\ldots\ldots\ldots (132)$$

for values of $K = n$ to $5n$.

Thus

$$V_{N1}/V_1 = (\gamma_1/Z) = a_1 \quad \ldots\ldots\ldots (133)$$

$$V_{N2}/V_1 = \frac{(\gamma_1+\gamma_2)}{Z} = a_2 \quad \ldots\ldots\ldots (134)$$

$$V_{N3}/V_1 = \frac{(\gamma_1 + \gamma_2 + \gamma_3)}{Z} = a_3 \ldots. (135)$$

$$V_{N4}/V_1 = \frac{(\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4)}{Z} = a_4 \ldots. (136)$$

$$V_{N5}/V_1 = \frac{(\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5)}{Z} = a_5 \ldots. (137)$$

where

$$Z = (\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5 + 1) \quad \ldots\ldots\ldots (138)$$

Therefore

$$\gamma_1/Z = a_1 \quad \text{or} \quad \gamma_1 = a_1 Z \quad \ldots\ldots\ldots\ldots (139)$$

$$\gamma_2/Z = (a_2 - a_1) \text{ or } \gamma_2 = (a_2 - a_1)Z \quad \ldots\ldots\ldots (140)$$

$$\gamma_3/Z = (a_3 - a_2) \text{ or } \gamma_3 = (a_3 - a_2)Z \quad \ldots\ldots\ldots (141)$$

$$\gamma_4/Z = (a_4 - a_3) \text{ or } \gamma_4 = (a_4 - a_3)Z \quad \ldots\ldots\ldots (142)$$

$$\gamma_5/Z = (a_5 - a_4) \text{ or } \gamma_5 = (a_5 - a_4)Z \quad \ldots\ldots\ldots (143)$$

Substituting these values in equation (137)

$$Z = \frac{1}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (144)$$

$$\gamma_1 = \frac{a_1}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (145)$$

$$\gamma_2 = \frac{(a_2 - a_1)}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (146)$$

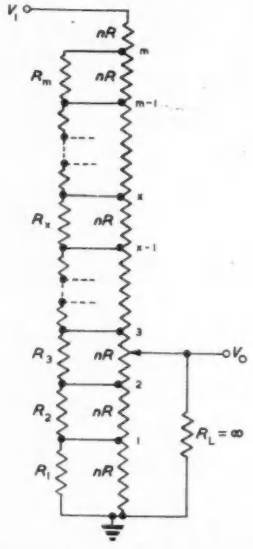


Fig. 12. Multi-tapped potentiometer with m equidistant taps

$$R_x = \frac{n(a_x - a_{x-1})R}{(1 - a_m - a_x + a_{x-1})}$$
where $a_0 = 0$

$$\gamma_3 = \frac{(a_3 - a_2)}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (147)$$

$$\gamma_4 = \frac{(a_4 - a_3)}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (148)$$

$$\gamma_5 = \frac{(a_5 - a_4)}{(1 - a_5)} \quad \ldots\ldots\ldots\ldots (149)$$

and by definition $\gamma_x = \dfrac{1}{n\rho_x + 1}$ and $\rho_x = (R/R_x)$ so that

$$R_1 = \frac{na_1R}{(1 - a_5 - a_1)} \quad \ldots\ldots\ldots\ldots (150)$$

$$R_2 = \frac{n(a_2 - a_1)R}{(1 - a_5 - a_2 + a_1)} \quad \ldots\ldots\ldots\ldots (151)$$

$$R_3 = \frac{n(a_3 - a_2)R}{(1 - a_5 - a_3 + a_2)} \quad \ldots\ldots\ldots\ldots (152)$$

$$R_4 = \frac{n(a_4 - a_3)R}{(1 - a_5 - a_4 + a_3)} \quad \ldots\ldots\ldots\ldots (153)$$

$$R_5 = \frac{n(a_5 - a_4)R}{(1 - 2a_5 + a_4)} \quad \ldots\ldots\ldots\ldots\ldots (154)$$

which by induction leads to the general result, that for equal spacings with m tapping points and no output load, and with no shunt resistor from the input terminal to the nearest tapping point (i.e. for potentiometers of the form shown in Fig. 12):

$$R_x = \frac{n(a_x - a_{x-1})R}{(1 - a_m - a_x + a_{x-1})} \text{ where } a_o = 0 \ldots . (155)$$

It can be seen that the value of R_x depends on R, the potentiometer winding resistance. This is because there is no shunt resistor between the m^{th} tapping point and the input terminal in the considered design. If there were, then the shunt resistor values would be independent of R, but in practice the resistor between the m^{th} tapping point and the input terminal should be omitted since it is essentially redundant and it reduces the input impedance of the network.

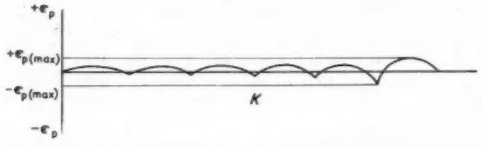


Fig. 13. Proportional error curve for loaded network

With the values for the shunt resistors determined by equations (150) to (154) the network will have (in the absence of an output load) the same maximum error as originally computed.

The next step is to compute the attenuation curve of the network in the presence of the minimum practical output load, e.g the input impedance of the succeeding d.c. amplifier, using the generalized equation and the substitutions derived for Fig. 4. From these values a new curve can be plotted and compared with the non-linear law curve to determine the new maximum error.

Provided the minimum practical output load is small some improvement in accuracy should be found, since under no-load conditions only positive errors are present, and the effect of introducing an output load is to cause the straight-line portions of the no-load curve to bow slightly downwards at the centre, and the tapping point voltages to decrease slightly below the non-linear law curve, thus introducing compensating negative errors (see Fig. 13).

It can be seen that if the output load is reduced too far, the negative errors produced will become dominant. Thus for a given set of shunt resistors there is an optimum value for R_L. If the minimum practical output load is inherently greater than this optimum, more tapping-points must be used to improve the accuracy.

At this stage, however, the design may well be satisfactory, but if further improvement is required the output load R_L can be optimized. The optimum value for R_L is that which produces equal positive and negative percentage errors.

The process of optimizing R_L if the non-linear function is only known graphically must be a process of trial and error by drawing out curves of error versus R_L, and by studying their shape choosing an appropriate value.

If the function is known in analytical form then an analytical approach can be adopted although the method may be very tedious compared with a graphical method.

Whatever method is chosen to compute the resistors required in the final refined design, it must be borne in mind throughout the design stage that ultimately the finished network has to be practically attainable, so that there is no point in optimizing on paper beyond the stability limits imposed by component tolerances.

Design Considerations

It is not necessary to have accurately linear windings for the potentiometer, although, of course, this greatly helps the preliminary analysis. Simple resistance bridge measurements can be made of the winding resistances between tapping points. Similarly the tapping points need not necessarily be equally spaced as again a simple dimensional measurement will provide values for n_1, n_2, etc.

The potentiometer's total winding resistance and the values of the shunt resistors must be considered as a whole in the final design, to determine whether the signal source will be capable of supplying the load presented by the complete network when the wiper is at the input terminal, which is the worse case.

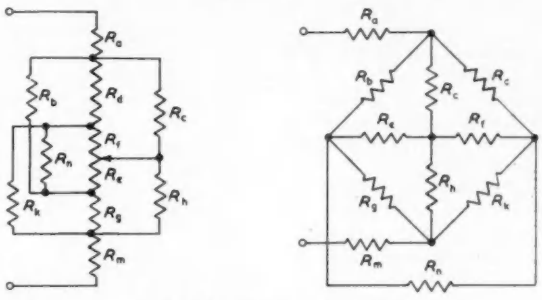


Fig. 14. Non-planar bridge network

The final design should not call for shunt resistors of excessive accuracy or stability.

Conclusions

(1) All multi-tapped potentiometers of the type described in this article can be represented by a single general network which can be further subdivided into one of four equivalent forms, according to the tapping arrangements and the position of the wiper.

(2) If equally spaced tapping points are chosen the design procedure is greatly simplified.

(3) The networks can be used to generate monotonic functions.

(4) The effect of output loading can in many cases be employed to improve the accuracy of fit of the generated curve.

(5) In conjunction with appropriate summing amplifier networks, multi-tapped potentiometers can be used to generate a wide variety of non-linear laws, e.g. secant, tangent, sine, cosine, logarithmic, etc.

Further investigation is needed to completely generalize all possible arrangements of multi-tapped potentiometers, which in their most general form become the non-planar bridge network of Fig. 14; and it is doubtful if the generalized equation for this would be simple enough for practical application.

References

1. Wass, C. A. A. An Introduction to Electronic Analogue Computers. (Pergamon Press Ltd., London, 1955.)
2. Korn, G. A., Korn, T. M. Electronic Analogue Computers. (McGraw-Hill Book Co., Inc., New York, 1952.)
3. Shen, D. W. Approximating Non-linear Functions. *Electronic Engng. 29*, 434 (1957).

ANALYSIS OF IMPACT NOISE

By F. M. Savage*

Instruments for the measurement and analysis of steady noise have made it possible to establish criteria for avoiding hearing loss in personnel exposed to continuous noise. The development of impact noise analysers should provide data for dealing with the even more dangerous impact noises. In this article a small portable instrument for the measurement of impulsive noise is described. The instrument may also be used for other purposes, such as the measurement of peak accelerations when used with a suitable accelerometer.

(Voir page 247 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 253)

IT is now generally agreed that hearing loss due to noise is a function both of length of exposure and of noise intensity. Although hard and fast rules regarding the time-dependence of ear injury cannot be made because of wide variations in the characteristics of industrial noises and in human response, modern electronic equipment coupled with an intelligent use of statistical methods has provided a scientific basis for determining safe noise levels for steady noise. The classic report[1] by a sub-committee of the American Standards Association, for instance, enables a realistic prediction to be made of the average hearing loss to be expected under a given set of steady conditions.

Impact Noise

An important limitation set on this work is imposed by the word 'steady'. With conventional sound level meters and analysers it is impossible to obtain an accurate reading on any sound which does not remain steady for a period approaching the time-constant of the meter (response time of the normal measuring circuit is about 0·25sec). While the meter needle will give a brief flick in response to such a sound, it will inevitably give a maximum reading between 15 and 30dB down on the signal peak. Yet all work indicates that such impact noises are a considerably greater menace to hearing than steady noise. Quantitative estimates of this physiological difference are however still very sparse, due to the difficulty in obtaining reasonable readings of impact noise under workshop conditions. Some work, it is true, has been carried out using cathode-ray oscillographs and cameras. The cumbersome nature of this equipment however precludes its use for any widespread survey such as would be necessary to place the results on a reasonable statistical basis.

A further disadvantage in the use of oscillographs is that while a great amount of information is obtained on such matters as waveform, the oscillogram yields no direct rating of noise, which is necessary as a basis for corrective action. Such quantitative information could readily be obtained if it were possible to extend the range of the conventional sound level meter to cover impact noise.

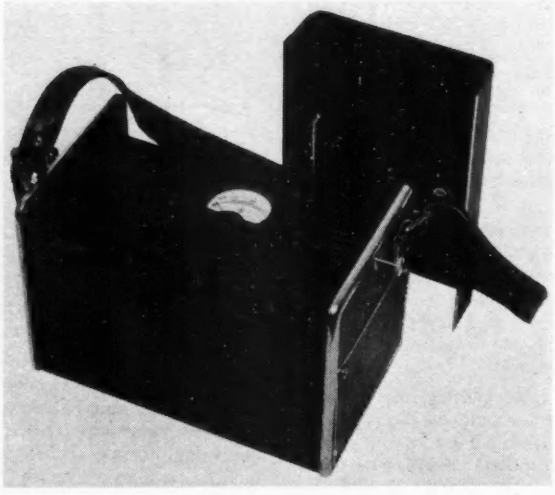


Fig. 1. The Dawe Instruments type 1412 impact noise analyser

A major problem facing the designer of an instrument for measuring impact noise is the selection of the most appropriate parameters for defining such a noise. Some guidance is available from the work of Rosenblith[2], who showed that the response time of the muscles in the middle ear to an impulse noise may be in the region of 10msec, or of the same order as the duration of the noise. This suggests that the initial peak of the impact tends to have a greater effect on the ear than the tail, and that the peak intensity may therefore prove to be the most important measure of the effect of impact noise on the human ear. In the case of the instrument described below it was therefore decided to consider peak intensity level and duration as the vital parameters, a further measurement of 'quasi peak' intensity being incorporated both for handling repeated impulses and to provide a practical method for calibration.

The peak intensity measured is the maximum sound-pressure level reached by the noise after the analyser control has been switched from the 'reset' position. The time taken to register the peak level—held by the instrument for a number of seconds for subsequent recording—is about 50μsec. Comparisons of the peak levels thus recorded have in general agreed to within 1dB with those obtained from a cathode-ray oscillograph. This means in effect that on this setting the instrument can be considered as instantaneous when operating on sound waves.

By contrast, the quasi peak reading provides a continuous indication of the higher sound pressure levels which have occurred between resetting and the time of indication. The relevant circuit has a fast rise-time below 1msec and a slower decay time of about 600msec, so that peak values can be followed reasonably well. This circuit is useful when impacts follow each other so rapidly that there is no time to take the peak reading before the next impact intervenes.

By applying a known sine wave input to the quasi peak circuit it is simple to achieve precise calibration of the instrument. On this circuit incidentally the instrument behaves substantially in accordance with the standard specifications[3] for a meter to measure electrical impulsive noise.

* *Dawe Instruments Ltd.*

The other important parameter, impulse duration, is determined indirectly. The 'time average level' of the noise is measured over a known period and the impulse duration estimated by comparing the time average and peak values. Naturally the waveform of the particular impulse will control the exact shape of the calibration curve used to derive peak duration. As described below, however, it is possible to make certain assumptions which will permit a reasonable estimation to be obtained without measuring the form factor in every case.

An important feature of the instrument is that the capacitors for measuring peak intensity, quasi peak intensity, and impact duration are permanently connected in circuit. All three capacitors are therefore automatically charged on each occasion without the need for action by the operator. Low leakage currents are achieved in the design: charges are maintained within 1dB of the initial value (for 10sec on the peak intensity capacitor and for 1min on the time average capacitor) under all normal conditions of temperature and humidity. Accurate readings of both intensity and duration can thus be obtained on the same impact merely by turning the selector switch. This feature eliminates the uncertainty caused by having to measure these two interrelated parameters on successive impacts which may well vary appreciably in magnitude and waveform.

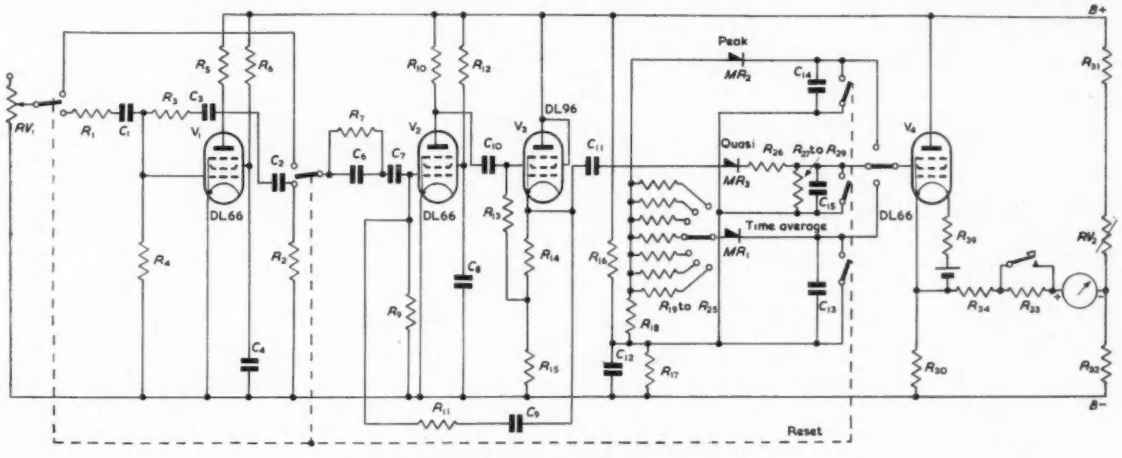


Fig. 2. Simplified circuit of impact noise analyser

The type 1412 impact noise analyser has been developed to provide an attachment enabling the Dawe type 1400 sound level meter to measure both impulsive and steady sounds. In addition to this prime function, the type 1412 analyser may also be used to measure peak accelerations when used with a suitable accelerometer or to analyse any impulsive waveform capable of supplying about 1V peak across 50kΩ.

The design adopted results in a readily portable instrument. Including dry batteries, the analyser weighs only 8½lb and measures 11½in by 7in by 8in overall. A general external view is given in Fig. 1.

Circuit Description

The instrument is completely self-contained, h.t. and l.t. power being provided by dry batteries. With the exception of the cathode-follower, the valves are sub-miniature types with a low filament current and thus a relatively low mutual conductance. As a result the circuit design required special care to provide a wide-band frequency response.

The signal is fed to a simple input attenuator RV_1 (see Fig. 2). Either the positive or negative-going pulse (increasing or decreasing pressure wave) can be selected for measurement. Negative-going pulses are switched directly to V_2 via C_7. Positive-going signals are passed to the anode-follower (V_1). The circuit constants of this stage are designed to give a gain of -1. This is achieved by arranging the value of R_1 to be slightly less than that of R_3, while the value of R_4 (supplying grid-leak bias to V_1) is very much greater than the combined impedance presented by R_1 and C_1 connected in series. The output from this stage (or negative-going pulses, if these are selected for measurement) is fed to a conventional pentode amplifier (V_2) via the capacitor C_7.

The output from V_2 drives V_3, a triode-connected cathode-follower. V_2 and V_3 are arranged to give a resultant gain of -10, providing a 10V peak level at full-scale deflexion of the valve-voltmeter. These two stages obtain overall feedback from R_7 and R_{11}, thus stabilizing the gain. High-frequency compensation is provided by C_6. This arrangement also provides adequate frequency response over a wide band. The bias voltage of V_3 is obtained from R_{12}, tapped into the cathode load. The voltage feedback introduced provides a lower source-impedance than could otherwise be achieved. This ensures rapid charging of the storage capacitors to the peak voltage through the silicon diodes, whose very high reverse resistance prevents the capacitors from discharging prematurely.

The silicon diodes MR_1, MR_2, and MR_3 are permanently connected to the output of V_3 and the pulses from V_3 are applied simultaneously to all three rectifier circuits (through resistors selected by the time-constant range switch in the case of the 'time average' circuit). Only positive-going pulses are thus offered to the valve-voltmeter. The low-leakage properties of the storage capacitors C_{13}, C_{14} and C_{15}, which are of course also charged simultaneously, provide sufficient time for the 'characteristic' selector to be switched to each of the three circuits and for readings to be taken, so that an impulse can be interpreted with all three rectifier characteristics. In the 'peak' network, C_{14} is directly charged, the peak voltage being also directly applied to the grid of the electrometer valve V_4. In the 'quasi-peak' network, C_{15} is shunted by a very high resist-

ance R_{27-29} which, together with R_{26}, provides a moderate rise period with a relatively slow decay period. The characteristics of the 'peak' and 'quasi-peak' networks and the effects of varying the time-constant in the 'time-average' network are shown in Fig. 3.

Special precautions were taken in the selection of components and in the layout of the circuit in this section of the equipment to maintain the high insulation resistance.

The outputs from the three rectifier-capacitor circuits are fed to the valve-voltmeter through a selector switch. After readings are taken, the polarity switch is returned to 'reset'. This discharges C_{13}, C_{14} and C_{15}, so that a new reading can be taken.

The silicon junction diodes used in this equipment have an extremely high reverse resistance, which is greater than $10^{10}\Omega$ in the case of MR_1 and MR_3, while MR_2 has a reverse resistance greater than $10^8\Omega$; the forward resistance of the rectifiers is relatively low.

A simple bridge circuit is used for the valve-voltmeter. The triode-connected valve (V_4) is aged for 24 hours to secure a low grid current. The filament series resistor R_{39} ensures that this is maintained in service. Zero setting of the valve-voltmeter is effected by the potentiometer RV_2. The correct bias voltage is obtained from a divider network consisting of R_{16} and R_{17}, the valve grid itself being open-circuit.

The h.t. and l.t. voltages can also be switched to the meter to indicate the state of the batteries under operating conditions.

Estimating Impact Duration

As mentioned before, the duration of an impact noise can be estimated from a knowledge of the peak and time average noise levels and of the waveform. It may be convenient to illustrate the method employed by reference to a simple rectangular pulse.

If the time-constant of the rectifier circuit is set to t seconds and a constant voltage applied, the resultant capacitor voltage will tend to build up until it eventually becomes asymptotic to the value of the applied voltage If, for instance, the application lasts for $t/5$ seconds, the capacitor voltage will still be 15dB down on the applied voltage. After a period of $t/2$ seconds, this difference will fall to 4dB and so on. When it is remembered that the impact duration represents the only charging time for the capacitor, this duration can be obtained directly, if rather laboriously, by plotting the difference on the graph shown in Fig. 3.

Unfortunately, impact noises are not simple rectangular pulses. Readings taken on oscillographs indicate that they tend, at least as a first approximation, to decay exponentially. Using this assumption it is possible to compute a curve to give a rapid conversion to impact duration (see Fig. 4). Comparison of impact durations obtained in this way with those measured on cathode-ray oscillographs show close agreement over a wide range of industrial impact noises.

The fact that the time-constant of the time average rectifier circuit can be varied offers a simple way of checking that the correct waveform has been assumed. Clearly if the curve of Fig. 4 is suited to the particular impact, the same impact duration will be measured irrespective of the time-constant setting. Bearing in mind that no two impacts are identical (the variation being particularly marked for sharply peaked waveforms such as those emitted by cartridge-operated hammers for driving studs into concrete), considerable confidence can be placed in results showing a reasonable agreement with a number of different settings of time-constant. Failure to achieve such agreement probably indicates incorrect assumptions on waveform. The actual variation in the readings will provide some guidance towards constructing a correct calibration curve which can then be checked by means of an oscillograph, if one is available.

Use with a Spectrum Analyser

From the previous discussion it will be apparent that the impact noise analyser can be used to meter the output from a spectrum analyser. It is not clear whether the measured

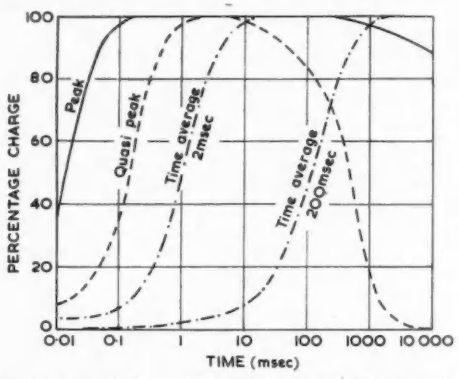


Fig. 3. Charge and decay characteristics for peak circuit, quasi peak circuit, time average circuit with low time-constant, and time average circuit with high time-constant.

By comparison of these curves it is possible to determine the decay time of any square waveform if the dB difference between peak level and averaged level is known.

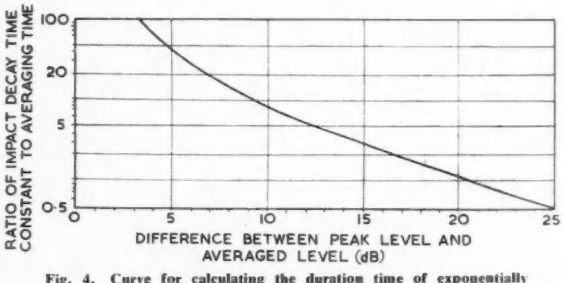


Fig. 4. Curve for calculating the duration time of exponentially decaying pulses

peak level in any band is physically significant in itself, since such a peak is not actually in the impact noise itself. In the absence of any better data, however, the reading would appear to give some numerical indication of the noise level within the particular band. It is also possible to use this peak level and the time-averaged level to determine an equivalent decay time for the noise in each band.

Having obtained such a decay time, it is important to consider the effect of filter response time. If a single tuned circuit is used as a filter, the response times will be fairly rapid. Such a filter is, however, not sufficiently selective for noise analysis. The use of more complex networks is therefore necessary to obtain greater selectivity, although this involves a corresponding lengthening of response time.

To put the whole matter in perspective, the ratio of the octave response times for a small press to those of the Dawe type 1410 octave band analyser, which is normally recommended for this purpose, never falls below about 6·6. For this class of noise at least, no special precautions need therefore be taken, since any ratio above 3:1 means that the response time of the filter is negligible in relation to

the duration of the impact noise. Naturally, before this assumption is made on any new application, it is necessary to carry out measurements of the particular noise under investigation and to compare them with the curve for the design of spectrum analyser in use at the time.

Selection of Microphones

The main requirement of a suitable microphone for an impact noise analyser is that its response should be similar to that of the human ear. Since this criterion was a major factor in the initial selection of the microphone for the type 1400 sound level meter, it is not surprising that studies using this type of microphone with an oscillograph indicate that a satisfactory performance can be expected.

An interesting point arises in deciding when a particular reading on the impact noise analyser represents a compression or a rarefaction stage of the sound wave. A simple method of settling this point for the first time consisted in placing the microphone in a container and providing a definite compression by forcing air into it with a tyre pump.

Conclusion

This impact noise analyser provides a theoretically correct measurement of peak level which agrees very closely with that given by laboratory equipment. This peak level is the parameter which is required for a great deal of work on the noise reduction of such equipment as punches and forging presses, guillotines, and even guns and small arms. It thus provides the best and perhaps the only way of comparing the effectiveness of different modifications.

Measurement of peak level is also vital in any programme aimed at preventing hearing loss in operators exposed to impact noise. The success of such programmes will undoubtedly throw more light on the response of the human ear to impulsive noises and may well advance our knowledge in this branch of otology to its present level for steady noise.

An untapped field is the possibility of using impact noise analysis as a measure of the efficiency of many industrial processes. Here again an accurate measure of peak noise would seem to be an essential prerequisite for success.

In many forms of acoustic survey, the need frequently arises for measurement of the vibration originating from impacts. This demand can also be catered for merely by changing the form of transducer used with the impact noise analyser.

This facility offers considerable advantages in the investigation of such problems as 'tyre thump' which has proved so troublesome to tyre manufacturers during recent years.

The derivation of impact duration by an indirect method naturally introduces the possibility of errors not present in a direct measurement of peak noise level. This parameter is however generally required to a lesser degree of precision than is a measurement of noise level. Accordingly the accuracy obtainable appears to be more than adequate for present requirements.

REFERENCES

1. The Relation of Hearing Loss to Noise Exposure. Report by Exploratory Sub-committee Z24-X-2 of American Standards Association (1954).
2. ROSENBLITH, W. A. Electrical Responses from the Auditory Nervous System. *Annals of Otology, Rhinology and Laryngology*. 3, 839 (1954).
3. B.S. 727 : 1954. Characteristics and Performance of Apparatus for the Measurement of Radio Interference.

Closed Circuit Television Equipment for Advertising Agencies

Two closed circuit television and telecine equipments have recently been installed in offices of advertising agencies in London.

The first of these was installed at the headquarters of London Press Exchange Television Ltd by Marconi's Wireless Telegraph Co. Ltd. Forty-three rooms, including the Board Room of the L.P.E. building have been wired to make use of the facilities afforded by the new system.

A feature of this installation is its extreme flexibility. Two Marconi BD871 cameras have been used and each can have a dual function. Mounted on a tripod stand and fitted with a zoom lens either can be employed for viewing auditions, casting or rehearsals in the theatre. Mounted on a pedestal in the projection room either is available for telecine work. In this position they can be swivelled to 'view' the film running through either of three projectors (two 35mm and one 16mm) or film strip in a slide projector.

For telecine operation the camera scans the film frame and produces video impulses which are fed together with sound signals into radio-frequency modulators and amplifiers. These are crystal-controlled miniature transmitters. The modulators feed their outputs into cables to the forty-three receiving points. In the same way the ouput from the auditioning camera is fed to another radio-frequency modulator and amplifier and similarly distributed. The receivers therefore have four radio-frequency signals fed to them, namely the BBC and ITA signals and the signals emanating from the cameras. It is planned to use one camera permanently for telecine and the other for use in the viewing theatre or for telecine as required.

The 35mm projectors can run either 'married or 'unmarried' prints and are modified to use magnetic stripe film. These projectors and the associated sound systems have been supplied by R.C.A. (Great Britain) Ltd, while the inter-office cabling has been carried out by Belling & Lee Ltd, both under subcontract to Marconi's.

The second installation is that at the London headquarters of the J. Walter Thompson advertising agency.

This equipment, installed and manufactured by Pye Ltd, transmits pictures to a network of receiving screens throughout the building. The telecine installation caters for 16mm and 35mm film or slides, and has facilities for running optical or magnetic sound tracks, including a 35mm Westrex magnetic machine.

A closed-circuit 'live' television system is also available.

Estimation of Depth of Blemishes in Glass*

Glass used for optical purposes often contains small imperfections which it may be possible to eliminate in subsequent grinding and polishing. In order to know if a particular sample is usable, one must know the depth of any blemishes below the surface. This can readily be done with the following apparatus.

It is assumed that one surface is optically clear. Immediately above the blemish to be examined, a microscope, having a short depth of focus, is focused on to the clear surface, most conveniently by using a fixed stop to contact the surface, or alternatively by marking it with dye or other material.

A gauge consisting of a graduated echelon or wedge of glass (or other transparent material) is placed over the blemish and moved across until the thickness of the gauge between microscope objective and blemish is such that the blemish is brought into clear focus at which point the depth of the blemish may be read off on the gauge.

If the glass being examined has the same refractive index as the gauge, the depth is given by

$d = (\mu - 1)t$ where d = depth of blemish
t = thickness of gauge
μ = refractive index.

So that for $\mu = 1{\cdot}5$ a depth of blemish d is measured using a gauge twice this thickness, thus increasing the accuracy of measurement. Also there are no errors due to backlash in the microscope movement as when using a travelling microscope.

If the refractive indices of gauge and glass examined are appreciably different, the gauge must be calibrated accordingly, in which case

$d = (\mu_2/\mu_1)(\mu_1 - 1)t$ where μ_1 = refractive index of gauge
μ_2 = refractive of glass being examined.

This method of depth measurement is particularly suitable if it is required to work between fixed limits.

* *Communication from E.M.I. Ltd.*

The Recording and Collocation of Waveforms (Part 2)

By R. J. D. Reeves*

(Voir page 184 pour le résumé en français:
Zusammenfassung in deutscher Sprache auf Seite 189)

The above photograph shows the Ekco strobograph

A Modern Strobograph

The Ekco Strobograph (illustrated on right) will be the first strobograph to be commercially available since Hospitaliers 'Ondographe' ceased production about twenty-five years ago, and the re-introduction of this technique closes the gap in present-day instrumentation by providing, once again, for the permanent recording of waveforms, but in this case waveforms of incomparably higher speeds. The significant advance that this represents over c.r.t. photography is not simply that of functional simplicity but that the presentation is precisely controlled in amplitude, so that measurements can be taken from the strobogram with a ruler at any subsequent time. Equally important is the fact that the instrument is direct coupled, so that multiple recordings can be made showing the spacing between related waveforms on the voltage scale with an accuracy no less than that provided for the measurement of the individual waveforms. This feature is not necessarily peculiar to strobographs, but is so rarely available that it provides a quite unaccustomed luxury to be able, for example, to collect the complete set of valve electrode waveforms properly disposed on the voltage scale for the true assessment of the instantaneous working conditions.

A more complex form of this instrument has two strobing channels and provides for the recording of families of curves being explored under periodic or pulse conditions, examples readily coming to mind being pulsed valve characteristics or high speed *B-H* curves.

Typically, these two applications depend upon the use of auxiliary apparatus specially designed to explore the characteristics in a recurrent manner, and it is envisaged that the two-channel strobograph will be mostly employed in a variety of specialized applications rather than the analysis of functional circuits. At 'mechanical' frequencies this form reduces to a simple *X-Y* plotting table with virtually continuous tracking.

Both forms of the machine are Class 2 with a vertical scale accuracy better than ½ per cent. An electronic sampling pulse provides a time resolution better than 3mμsec, and a voltage controlled delay system has a linearity better than 5 per cent. The servo system is a velocity lag type using a 50c/s a.c. motor and tachogenerator, and the strobe pulse is manually advanced by a handwheel.

There are three scale ranges per decade, covering sensitivity ranges from 50V/in to 0·5V/in, and time scales from 500μsec/in to 0·1μsec/in, the recording paper being 10in by 7½in.

The repetition rate generator is variable from 200c/s to 15kc/s and can be locked to repetition rates up to 150kc/s, with aural and visual indication of the synchronizing condition.

Mechanical Features

The instrument is built into a mobile rack frame, with side doors giving ready access to the units. Each unit has vertical chassis with components on the outside and valves projecting inwards. This arrangement permits a planned airflow in the centre of the unit, using wide apertures beneath and above the doors. At the very bottom of the frame a drawer is provided for recording paper.

The plotting table is tilted up at 45° to provide perpendicular presentation to an operator standing in front of the machine, and this arrangement conveniently submerges the pen drive mechanism beneath the main table. In this way, a clean appearance is obtained and there is ample space on the table for the annotation of strobograms.

* *Solartron Electronic Group Ltd, formerly E. K. Cole Ltd.*

The recording pen is actuated by a steel tape drive which differs from usual in the use of bowed tape in place of flat tape, which can transmit thrust as well as tension forces and therefore requires no return loop. This tape is fed off a flat drum and takes up the bowed form as it leaves; the thrust being provided by a second 'backing' tape which is fed off with it and is reeled up on a drum on the shaft of the reference potentiometer.

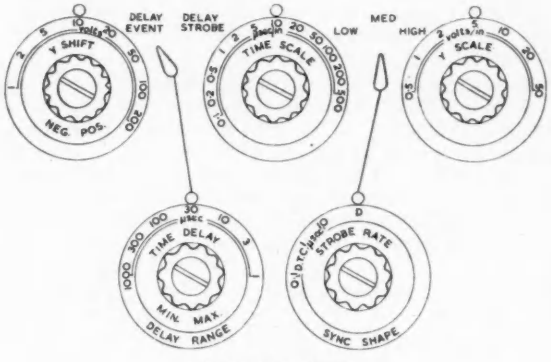


Fig. 10. Control panel

The illustration on page 204 is of a double channel machine with two signal probes. Notice the small complement of controls for this very general purpose instrument, and in the case of a single channel machine the controls number two less, namely five, which is illustrated in Fig. 10. This simple layout results from the integration of several related controls into one knob, and from the fact that in a strobograph there is no focus, brightness, astigmatism, set zero etc., and in fact the only incidental control is a loudspeaker on-off switch.

In each case where a control covers a wide range (namely those concerned with 'shift' and 'repetition rate') the range switch is operated by the limit stops of the fine control, and is actuated in a natural way at the limit of the fine range. A third control can be engaged by a dog clutch brought into operation by pressing the knob. Where this is incorporated a separate flag is necessary to indicate the setting of the third control.

A shaft which is identified with table movement is available at the rear of the instrument for the attachment of an external potentiometer or synchro, so that the *X* scale can be identified with some parameter other than time. By this means using the *Y* channel as a recording d.c. voltmeter, the instrument may be employed to plot families of response curves, characteristics etc., without recourse to two-channel working.

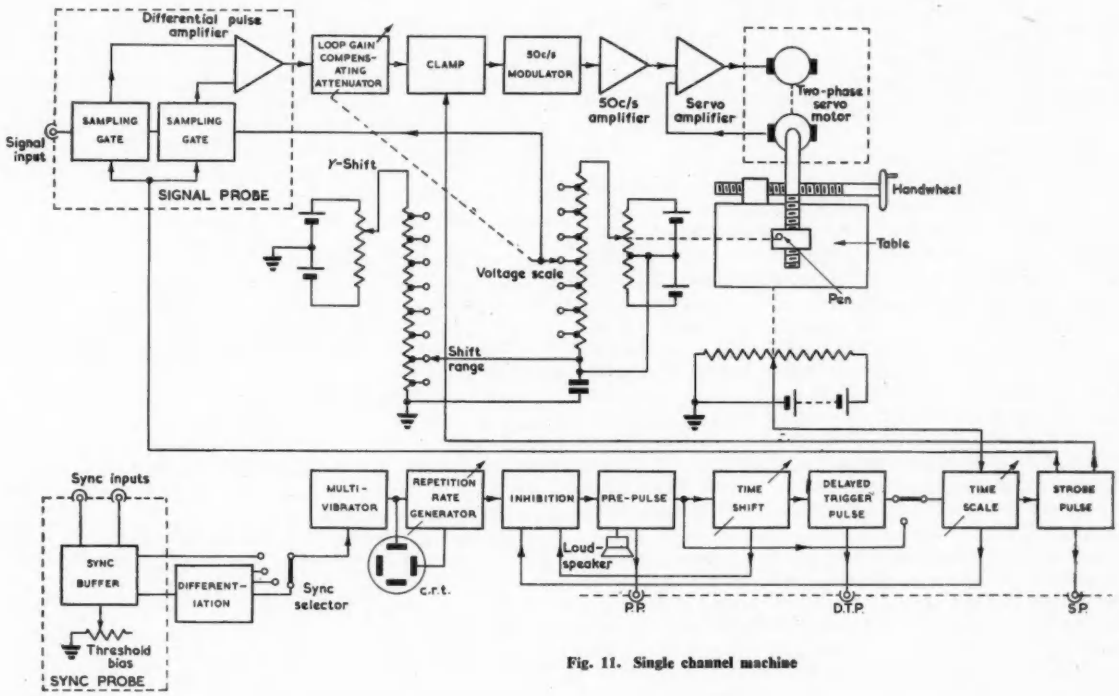


Fig. 11. Single channel machine

The drive to the moving table is a simple rack and pinion arrangement with anti-backlash coupling to the pick-off potentiometer. In the double-channel instrument where the table has to track a signal waveform a specially light table is constructed of aluminium honeycomb.

Scales are provided on the pen and table not as a part of the measuring procedure but as an aid to operating, so that significant instants or voltages can be noticed. A separate scale is essential, however, for the handwheel if this is not associated with *X* displacement.

Fig. 11 is a block schematic of the single-channel machine and the function of the component units is described in the following sections.

The 'Repetition Rate' Generator and Synchronizing Arrangements

A probe is provided for the synchronizing signal so that if this should happen to be the input signal itself the minimum loading of the source is obtained. This probe is carried on a separate lead to the signal probes for greater

flexibility and to avoid any possibility of crosstalk within the instrument.

One double triode is used in the probe, connected as a long-tailed pair; synchronizing signals being applied to one grid or the other depending whether the intention is to synchronize at a positive excursion in the waveform or a negative going one. This valve has a threshold bias variable from 0 to 50V which can be used to suppress interference or unwanted parts of the waveform below the indicated level, and the prepulse in the instrument will be triggered as it crosses this level.

The output is connected to a slave trigger circuit which produces a square waveform of fixed amplitude which follows the synchronizing signal as it crosses and recrosses the synchronizing threshold. It is completely absent if there is no synchronizing signal. This waveform is used to synchronize the repetition rate generator and is also displayed on a small c.r.t. as a visual aid to synchronizing.

The 'repetition-rate' generator is a free running relaxation oscillator, continuously variable in three ranges from 200c/s to 15kc/s. This oscillator takes the form of a Miller transitron circuit with a controlled bottoming level and auxiliary flash-back valve. The fine tuning is by control of the grid potential and the range switching by the Miller capacitor. A linear stroke circuit of this kind is to be preferred to the simpler exponential wave generator for two reasons, one being simply that the waveform can be used as a display base in the oscilloscope, but more important is that the instant of flash-back is well defined, being the time at which the run down traverses the bottoming potential. This is less prone to jitter than an exponential approach.

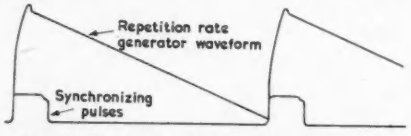


Fig. 12. Synchronizing the repetition-rate generator

The (shaped) synchronizing wave is superimposed on the bottoming potential and the positive excursions momentarily raise the bottoming level and thus shorten the run-down period if the run-down is near to terminating at that time. In this way the synchronizing signal has a tendency to raise the repetition frequency and lock it into its own rate, or a sub-harmonic thereof, the condition being obtained by suitable adjustment of the free rate control. The repetition-rate generator waveform and typical synchronizing pulses are shown on common time and voltage scales in Fig. 12.

Sub-harmonic working is achieved by limiting the amplitude of the trigger waveform so that only trigger pulses occurring near the natural bottoming time are effective and earlier ones are missed, the simplest case being illustrated in Fig. 13. A small amplitude trigger pulse makes a large division possible but requires accurate setting of the rate control. A large trigger pulse on the other hand, reduces the division ratio that is possible but is less critical of the free rate setting. Reliable division up to 10:1 is a suitable compromise to aim for.

The repetition-rate generator in its turn fires a blocking oscillator, the pulse from which is termed the 'pre-pulse' and initiates the time delay circuits. This happens when the repetition generator flashes back, and so immediately follows the incoming synchronizing signal. The pre-pulse is also brought out to the front panel for use as a marker or trigger pulse.

Interposed between the repetition-rate generator and the pre-pulse generator is an inhibitor circuit which prevents the pre-pulse being fired if the delay circuits have not completed the previous strokes, which could cause faulty operation of the delay circuits. By virtue of the inhibitor the pre-pulse frequency may be sub-harmonic to the repetition-rate generator just as, in its turn, the repetition rate generator may be sub-harmonic to the synchronizing signal.

A small loudspeaker is connected to the pre-pulse generator (or the subsequent strobe pulse generator) and provides an aural aid to synchronizing, this completing the features available for synchronizing shaping and monitoring.

In the absence of a synchronizing signal the repetition-rate sounds pure at all frequencies and can be tuned in a continuous manner. In the presence of a synchronizing signal the repetition-rate frequency proceeds in a series of jumps as it is tuned past the sub-harmonic frequencies, and pulls in strongly to the fundamental. At frequencies between the sub-harmonics or above the fundamental the tone sounds harsh as some repetition periods are shortened

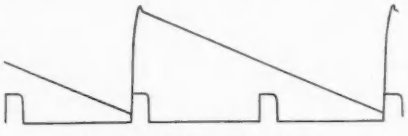


Fig. 13. Sub-harmonic working

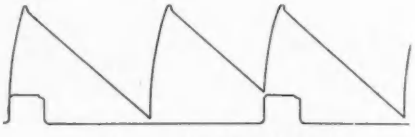


Fig. 14. Harmonic locking (Incorrect)

but not all. By this means the proper settings are easily distinguished and even one 'slipped' pulse is easily heard. An incorrect setting of the repetition-rate generator is illustrated in Fig. 14 which produces pulses at twice the signal repetition rate which is an inadmissable condition for the purpose of strobing.

On the c.r.t. the synchronizing signals are displayed with the repetition period as a display base and the significant synchronizing pulse which actually triggers the repetition period may or may not be visible depending on its duration. But the missed triggers are all visible and if these are stationary and tend to remain so in spite of small adjustments of the rate control then the instrument is firmly locked, and the number of visible pulses reveals what sub-harmonic is being employed. Faulty tuning below the fundamental frequency will show a blurred display or unevenly spaced pulses which are not stable in position.

The functioning of the inhibitor is not indicated on the c.r.t. but is apparent on the loudspeaker, which always indicates true strobe rate. Switching to time scales which are longer than the repetition-rate generator period produces sub-harmonic tones.

Careful measurement reveals that when pull-in is apparently accomplished there is residual jitter between the input synchronizing signal and the pre-pulse which is proportional to the amount of pulling which is necessary to enforce the synchronism. This is not indicated on the monitors, so when the fastest time scales are being used a mental note must be made to tune to the high frequency end of the locked arc on the rate control, where the free rate is most nearly equal to the synchronized rate.

It may appear that these arrangements for synchronizing are rather elaborate, but this complexity arises partly from a desire to provide comprehensive facilities in the instrument and partly by the special problems of synchronizing a strobograph. As the waveform presentation is not mobile there is no direct indication of the synchronizing condition unless special aids are provided, and so some auxiliary presentation is essential. Furthermore, it is not permissible to use a triggered repetition-rate generator because the motor servos depend on the recurrence of the strobe at a minimum repetition-rate in order to keep the control loop closed. This is why the repetition-rate generator is designed to free-run in the absence of a trigger signal and is properly described as a synchronized oscillator rather than a triggered one.

Clearly, successful strobing depends upon accurate synchronizing and in a general purpose instrument every effort must be made to provide this over a wide range of conditions.

Time Delay Circuits

There are two independent delay circuits, one being associated with time scale and controlled by the handwheel, and the other with the time shift control. The circuits are similar but the time shift circuit is not accurately calibrated and has only two ranges per decade.

A linear run-down and flash-back is produced in just the same way as in the repetition-rate generator, but instead of free running these circuits are of the one-shot type, and wait at the start potential until a trigger pulse is received. This is accomplished by returning the suppressor grid leak of the Miller valve to a cut-off bias and using the trigger pulse to overcome this bias and initiate the run-down, the action being sustained by regenerative (transitron) coupling between screen and suppressor. Flash-back is automatic when the bottoming potential is traversed.

The bottoming potential is fixed so that the run-down stroke is of fixed amplitude; but variable delay is produced by a pick-off circuit which fires a pulse when the run-down crosses a variable pick-off potential. This circuit does not react on the run-down in any way, so the paralysis time of the delay circuit is independent of the pick-off potential and depends only on the delay range. This in an important point when the range called for exceeds the repetition period of the synchronizing signal because then, through the medium of the pre-pulse inhibitor, the time delay circuits govern the strobe rate, and this must be independent of the strobe position or the synchronizing setting could change in the course of a plot.

The time shift delay circuit is always triggered by the pre-pulse, and the pick-off circuit associated with it fires a blocking oscillator termed the delayed trigger pulse generator. The delayed trigger pulse can therefore be made to occur at any time subsequent to the pre-pulse according to the settings of the time shift and shift range controls.

The second delay circuit, the 'time scale' delay, may be initiated by the delayed trigger pulse so that the time scale represented on the paper is delayed with respect to the pre-pulse. This mode of working is called the 'delayed strobe' condition and it corresponds to normal X shift facilities in other oscillographs, but an alternative mode of operation is provided called the 'delayed event' condition, in which both delay circuits are initiated by the pre-pulse and the delayed trigger pulse is fed out to trigger the circuit under observation. When the external apparatus can be 'slaved' to the strobograph in this way the X shift control is apparently reversed and the strobe is advanced with respect to the event by the shift control, and the range of the presentation is extended to times prior to the event under observation instead of being confined to subsequent times, as would be the case in the delayed strobe mode if there were no prior synchronizing signal.

This mode of operation is not so restricted in application as might be imagined, because the strobograph can be freely set to a repetition-rate appropriate to the external circuit, and experimental pulse circuits may be deliberately constructed without a repetition-rate generator with the intention of slaving them to the strobograph.

The time scale is normally the X scale of the paper, but when two channel working is employed, the time scale is parametric and follows the convolutions of the trace. In this condition a separate scale coupled to the handwheel indicates the progress of the strobe pulse and the trace can be annotated from this if required.

In the case of the time scale circuit the pick-off potential is controlled by a precision potentiometer energized by a stabilized power supply, and rigidly coupled to the X co-ordinate of the table (when appropriate) so that the accuracy of the time scale is not appreciably less than that of the waveform of the delay circuit. The linearity of this may be considered to be slightly greater than is customary in a cathode-ray oscillograph because it is not paraphased or loaded for any purpose other than the pick-off circuit. The pick-off circuit itself is isolated from the Miller waveform by a diode, and the onset of conduction here initiates the output pulse so that any loading this circuit may produce is subsequent to the pick-off and not relevant to the linearity. This pick-up action has some similarity to a multiar but uses a two-valve trigger circuit with a slave blocking oscillator to give a firm indication of pick-off.

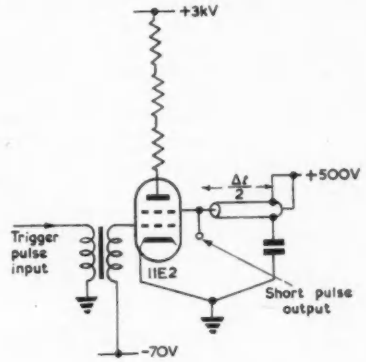


Fig. 15. 'Screen step' circuit

The delay range switching is by the Miller capacitor which is accurate to ±1 per cent and the variation in bias on this valve may cause the discharge current to vary a further ±½ per cent, so that altogether it will be possible to state the time scale (μsec/in) to a precision better than 2 or 3 per cent, but it can be more accurately calibrated by supplying specimen strobograms on all scales of precision frequency oscillators.

Thus without employing the special methods peculiar to strobography for controlling the time scale the accuracy may still be comparable to the best that is currently available.

Strobe Gate Generator

The pick-off circuit associated with the time scale delay fires a pulse called the strobe marker pulse, which has three functions to perform. It has to trigger the actual strobe gate generator which is the ultimate function of the time delay circuits, it has to drive the demodulating clamp which

converts the error pulse from the signal probe to a d.c. signal and it is fed out for external use to mark the strobe instant if this should be of some interest in the procedure.

The strobe gate generator is the very heart of the instrument and might well have assumed some complexity, but in fact it is realized in a very simple form indeed. The essential action is obtained by rapidly bottoming a tetrode or pentode which has a sharp knee in the anode characteristics, and in this way causing a heavy current to suddenly divert from the anode to the screen. The resulting screen current step is differentiated by a shorted delay line to produce the required short pulse. This 'screen step' may be brought about in two distinct ways, of which Fig. 15 shows the method which is the simplest to understand. The strobe marker pulse which itself is a moderately fast blocking oscillator pulse of 0·05μsec rise-time and 0·5μsec duration, drives the tetrode grid from cut-off to about 50V positive and finally produces about 2A of anode current. The anode load is a high value resistor so that the anode current flows into the stray capacitance and causes a rapid fall of anode potential. The speed of this descent is proportional to the current and will not reach a maximum until the drive pulse has reached full amplitude. In order to allow time for this build up the anode is returned to a very high potential so that bottoming does not occur before 0·05μsec have elapsed. Although some screen current flows from the beginning according to the usual partition laws the delayed screen step is over 1A and is easily distinguished by a differentiating line.

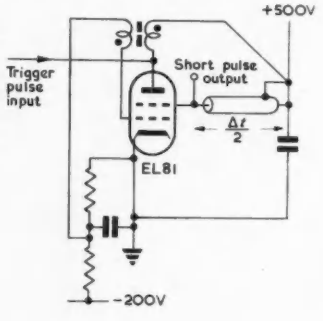


Fig. 16. Regenerative 'screen step' circuit

It will be seen that the switching action takes place entirely within the electron stream of the valve and the technique may be fairly described as an electron switch. The most apparent drawback to this arrangement is the necessity for a high anode supply voltage, although there is negligible current drain on it. For this reason the circuit of Fig. 16 was investigated and made to operate from normal supplies in an even more satisfactory manner. The intention here is to retain the screen step action but to have the valve drive itself into conduction by a regenerative transformer. This ensures that the anode descends no faster than the grid is rising without a high anode delaying potential, but the problem is now one of designing a transformer which permits a very rapid rise of voltage on both these electrodes. This is tantamount to designing an extremely fast blocking oscillator as such, and certainly the dividing line between this circuit and a conventional blocking oscillator is a fine one, but the screen connexion produces a significant difference in performance. The transformer waveform is marred by the superposition of the inevitable trigger pulse which must be applied to initiate the blocking action, and this is a comparatively slow waveform. Also the valve does not perform well when the bias is still near cut-off and it is commonly recognized that blocking oscillators are 'slow starters'. Consequently the transformer waveform only exhibits the maximum rate of rise when the step is well under way, and any tertiary output is contaminated with the slow start. On the other hand the screen output waveform has a very sudden onset at the instant of bottoming and quite apart from that the rate of rise obtained is normally better than that seen on the transformer. It must be remembered that this edge is not concurrent with that on the transformer and although the speeds of the two are related they are not manifestations of the same current avalanche but successive ones.

The best valve for this purpose discovered so far is the EL81 and the transformer used in conjunction with it is illustrated in Fig. 17. The cores are 3½cm lengths of Ferroxcube A4 material with o.d. 4mm and i.d. 2mm. It will be seen that this provides an extremely short magnetic path. The primary and secondary are each two turns of

Fig. 17. Strobe pulse transformer

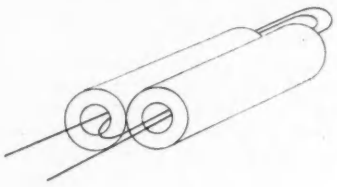
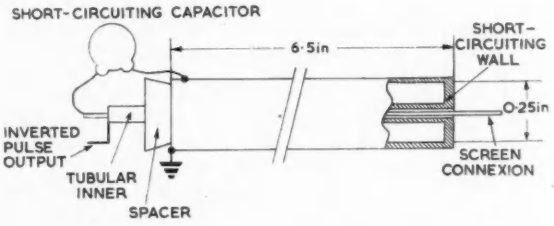


Fig. 18. Differentiating transformer



30 gauge X grade Lewmex copper wire with the shortest possible connecting leads, the top cap anode being returned via a 'skeleton' coaxial tube over the valve to minimize the inductance of the connexion

With 500V across the valve the EL81 drives itself into four or five amperes of anode current of which three to four are transferred to the screen, but in this application it is convenient to employ the normal h.t. lines and be content with lower values.

The pulse that appears across the differentiating line is necessarily of negative polarity and has to be inverted for use in the probe. This is done quite simply by providing the line with two inners in close proximity and connecting them to the outer at opposite ends. The line may then be thought of as a distributed differentiating transformer which inverts the signal. The pulse is attenuated through the device somewhat because of the capacitive loading at each end and because of the coupling factor. Coupling is maximized by having one hollow inner with the other threaded through it. The arrangement is shown in Fig. 18.

Signal Probe

The manner in which the strobe pulse is used for sampling the signal has already been outlined. The detailed arrangements are shown in Fig. 19. The two pentagrids have a cut-off bias on grid 1 and are gated on together by the strobe pulse. Grid 3 of the left-hand valve is the input terminal for the signal, and the corresponding grid of the right-hand (reference) valve is connected to the feedback potential which is associated with the *Y* co-ordinate of the

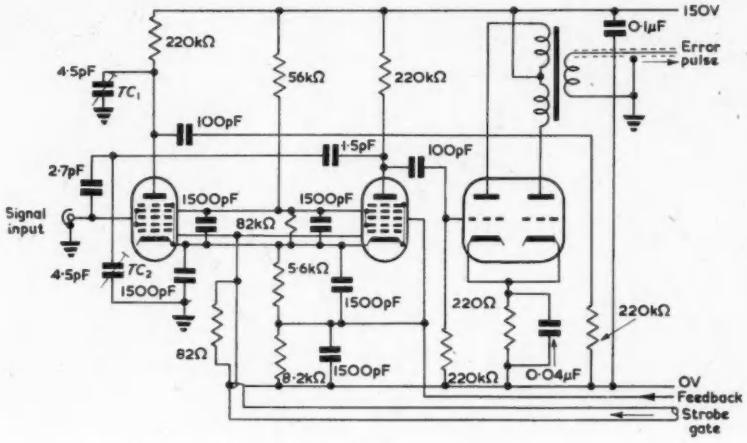


Fig. 19. Signal probe circuit

pen. The power supplies to the probe unit are referred to this potential, not earth, so that at balance the working conditions of the input stage are constant.

As a consequence of the strobe gate each valve passes a pulse of anode current of magnitude depending on the grid 3 potential. If at that instant the signal voltage is the same as the feedback potential both valves are operating under the same conditions and the two pulses are equal in magnitude, otherwise the pulse from the input valve will be larger or smaller depending whether the signal is more positive or more negative than this. The anode resistors are large, so that the current pulses charge the stray capacitors and produce a negative voltage step with time of rise equal to the effective gate duration. This step relaxes to its former value with a time-constant determined by these stray capacitances and the anode load. The negative voltage pulses so formed are fed through a buffer amplifier to a differential pulse transformer, which feeds out, at low impedance, a pulse termed the 'error' pulse which is related in sign and magnitude to the difference between the signal and feedback potentials at the instant of strobing.

Some of the practical considerations which arise in this process are as follows: The shape of the strobe gate pulse is not rectangular and consequently the effective sampling time depends very much on the grid 1 bias, and since the anode stray capacitances integrate the valve currents over the gate period the error pulse amplitude is directly affected by variations in gate length, and this is one of the factors determining the servo loop stiffness. It is important, therefore, to stabilize the supplies to the strobe gate generator and also the bias on grid 1 of the probe valves.

The anode pulses which are to be subtracted do not have a well-defined decay time, this being governed by stray capacitances. If their decay times are not the same, differencing will never produce a complete null, and for this reason a trimmer is introduced to make provision for balancing these stray capacitances.

This procedure is integral with the process of neutralizing the circuit from the effect of capacitive injection of the signal input from grid 3 to anode. Residual capacitance from grid 3 to anode is unavoidable and its effect is serious because it enables signals to by-pass the strobe gate but its effect can be balanced out by providing a corresponding coupling from the input to the anode of the reference valve. A very small capacitance is involved here, so in order to permit practical component values the input is first attenuated by a capacitive divider before coupling through. In the circuit diagram TC_1 is the neutralizing trimmer and TC_2 is the capacitance balance.

The Servo System

The sequence of events described so far, relating the acceptance of a synchronizing signal to the production of an error pulse is that concerned with the strobing of the input waveform, whereas the residual functions are concerned with the servo problem of tracking. Reference to Fig. 11 shows how the voltage from the slider of the pen monitor potentiometer is attenuated by the Y scale control to provide any suitable feedback coefficient of volts per inch. This control, therefore, directly alters the servo loop gain and would cause fluctuations in stiffness if it were not compensated elsewhere, but the ladder attenuator immediately after the probe offsets this effect so that the loop gain is independent of the sensitivity setting. From this point onward the error sensitivity bears a fixed relation to the pen displacement.

In order to minimize the necessary mechanical maintenance in this equipment the decision has been taken to employ a.c. servo motors in preference to d.c. so that the commutator is eliminated. The error information which is encoded in pulse amplitude has therefore to be translated into a proportional 50c/s signal, and the first step in this process is to translate it into d.c. This is accomplished by the two diode shunt modulator or 'keyed clamp' of Fig. 20, which is triggered by the strobe gate. Adjustment of

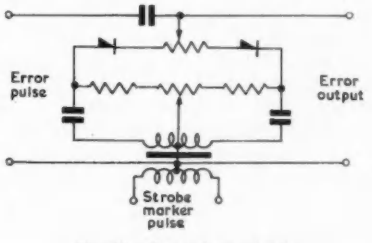


Fig. 20. Error clamp circuit

Fig. 21. Error modulator

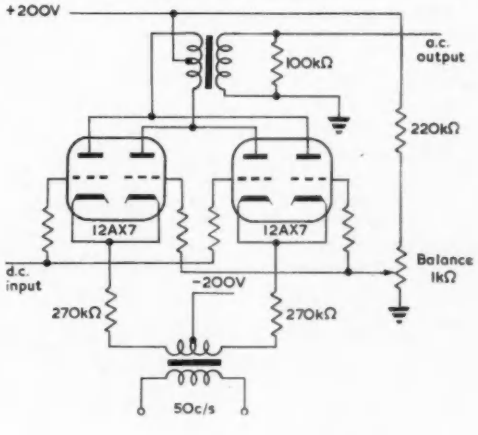


Fig. 22. Error channel transfer characteristic

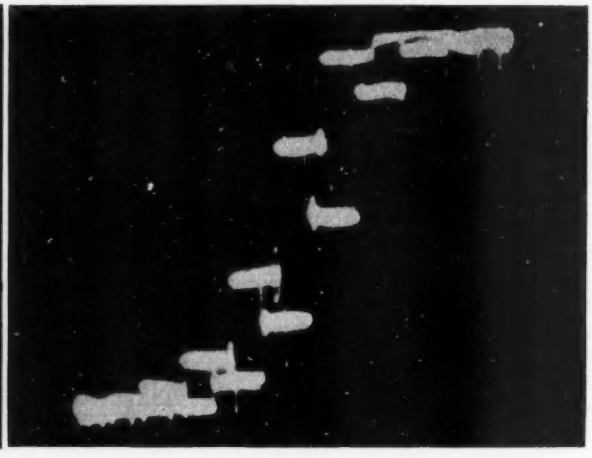


Fig. 23. Sampling lags in error channel

both the forward resistance and the relaxation time constants is necessary if it is to behave absolutely independently of pulse repetition rate.

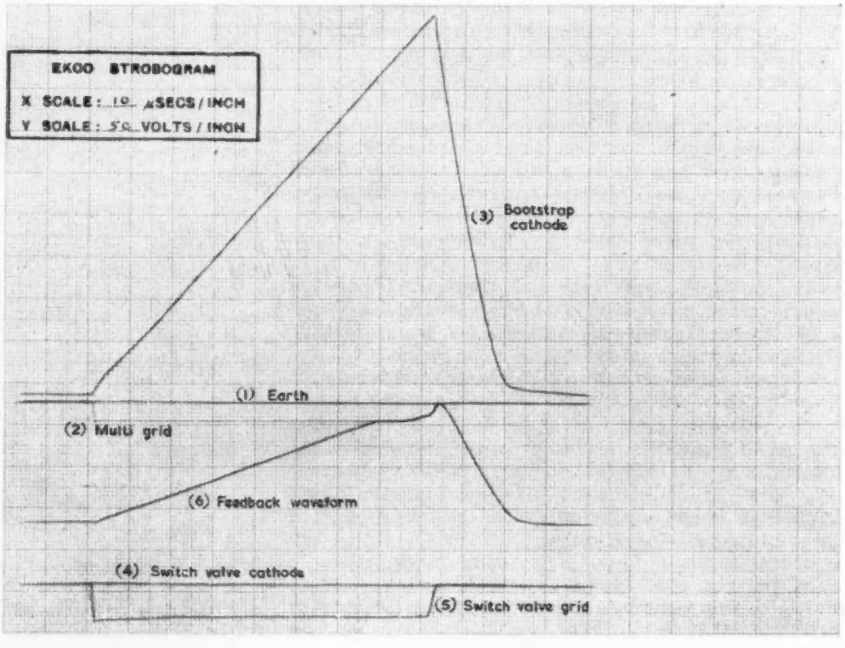
The conversion of d.c. to a.c. is a familiar problem but the restrictions associated with it in connexion with servo applications precludes many of the possibilities. In the first place any sampling process such as thyratrons or a magnetic amplifier is unacceptable because of the bandwidth limitations this imposes on 50c/s systems. The classical diode modulators are free from this defect and operate instantaneously, but since they produce square not sinusoidal waveforms these cannot be employed either. This is not because such a waveform cannot be applied to the motor itself but that at a subsequent point in the servo amplifier the error signal must be opposed to the sinusoidal tachogenerator on the motor shaft to introduce controlled damping. After this differencing point the harmonic content is increased by the tacho loop gain and will saturate the power amplifier.

The modulator that is used should be a true suppressed-carrier modulator, with undistorted output and instant response, and the choice narrows down to the use of valves as variable impedance elements. Fig. 21 shows the arrangement in which there are two similar long-tail pairs with a (common) differential transformer in the anode circuits. The modulating signal is fed to one grid of a pair and alters the distribution of the constant current from the 'tail'. Since the mutual conductance of a valve varies with the standing current this process effectively modulates the incremental impedance of the cathodes so that a super-imposed 50c/s carrier current is also proportionally controlled. When the grids are at the same potential the carrier current divides equally and is annulled in the anode transformer. Variations in the relative grid potential then produce a 50c/s difference signal in this transformer. The other pair is paraphased with this to produce the same effect as far as modulation of the carrier is concerned, but having direct current surges of the opposite phase. Provided the valve characteristics are reasonably well matched these surges sum to zero in the transformer.

After adding the tacho signal a conventional power amplifier is used to drive a two-phase servo motor in which the phase shift for the reference winding is obtained by dropping a high voltage supply with a capacitor.

The fact that the error information is being sampled does not influence the behaviour of the loop provided the

Fig. 24. Strobogram of 'bootstrap' waveform



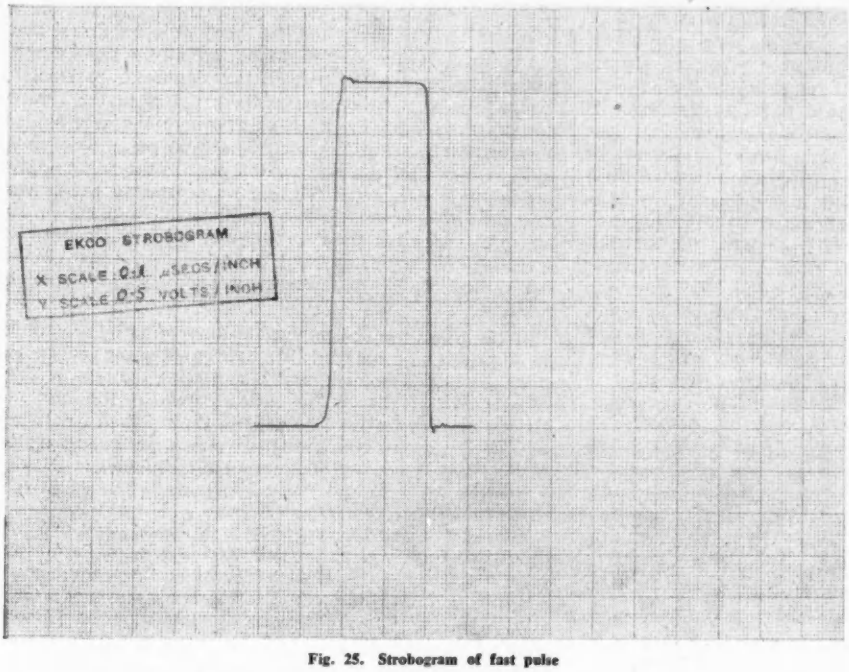


Fig. 25. Strobogram of fast pulse

sampling rate is high compared with the bandwidth. In this case the servo bandwidth is about four cycles, but significant lags are introduced when the error is being sampled at less than 150c/s and it is this factor which limits the lowest permissible repetition-rates and time scales. This is typical of the Class 2 machine.

Fig. 22 shows the transfer characteristic of the error channel as revealed by a low frequency input excursion with the servo motor switched off. Fig. 23 shows the dispersion of this characteristic when the sampling rate is low, which, of course, is similar to a phase lag in the response.

Another characteristic of this instrument is a maximum velocity constraint due to probe saturation. The probe which is handling high level signals has a limited range of error for which it can provide proportional indication, and on the lowest sensitivity range this may represent quite a small range of pen movement. In the steady state the pen velocity is proportional to the error existing but in the presence of gross errors probe saturation will limit the pen velocity. Gross errors are typical when the input is being reconnected, and the effect is that the pen is apparently less lively than on the more sensitive ranges. In fact, within the range of acceptable error which means under typical tracking conditions, the pen behaviour is independent of the sensitivity range.

Two-Channel Working

That type of machine which provides for two-channel working must also be capable of working as a single channel system and simple arrangements provided for the transition between the two states. The duplicate channel comprises signal probe, error amplifier, servo power amplifier, and servo motor, and the handwheel is no longer mechanically coupled to the X traverse. As a two-channel system the handwheel merely shifts the strobe pulse through the time scale while both X and Y are tracking their respective input signals. To reduce to single channel working it is necessary to obtain a position signal from the handwheel and route this through the X channel with fixed shift and sensitivity settings, so that the table follows the strobe pulse as though it were mechanically linked. As a refinement the strobe position may now be picked off the table movement to eliminate tracking errors. All these operations are performed by plugging the X probe into a socket provided under the table top, in which the centre pin carries the handwheel position signal and the sleeve operates a 'metamorphosis' relay to accomplish the other changes. In this way there is no explicit control associated with the transition between the two states and there is no possibility of partial transition due to incomplete operating procedure.

The strobe source is bifurcated for the X and Y probes after the distributed inverting transformer and the gates occur simultaneously. There appears to be no occasion to require displaced gates in the two channels.

Conclusion

The machine that has been described in the second part of this article has been designed for the most general application in a field which has been formerly reserved for cathode-ray oscillography, and will no doubt find a very wide application. The time resolution and voltage measuring accuracy probably exceeds that of commercial cathode-ray oscilloscopes while the time scale accuracy and sensitivity ranges are of corresponding standard. The low frequency end of the time scale ranges is curtailed in order to retain the overall feedback feature, although this part of the spectrum is not denied to strobographs, as evidenced by the specialized machines now in use.

The extremely flexible possibilities for multiple presentation with mixed or common scales makes the method advantageous even before considering the value of the permanent recording, and the significant thing about the strobogram is that it is produced to an accurately controlled scale, so that the decision to perform a measurement or not may be deferred indefinitely. The only immediate annotation that is necessary is to indicate what the scales are.

The possibility of multiple recordings may appear to be nothing but a facile attempt to claim comprehensive facilities where none exist. In fact, the method of time sharing in one channel, even on a lethargic scale, is the best method to ensure identical scales in the collocation of the waveforms, and in this way the indicated intersection of waveforms may be relied upon absolutely.

This point is evident in the strobogram of Fig. 24, which is a family of waveforms from a 'bootstrap' time-base. These were plotted successively without adjustment of the controls so they are correctly disposed on a common vertical scale.

Waveform (1) is the earth potential from which all

measurements may be taken; waveform (2) is one grid of a Schmidt trigger which is controlling the time-base; waveform (3) is the cathode of the bootstrap valve; waveforms (4) and (5) the cathode and grid respectively of the switch valve which releases the bootstrap. The bootstrap valve is seen to wait 5V above earth until the Schmidt grid goes negative (12V), which causes a simultaneous movement of the switch grid (22V). Waveform (6) is an attenuated form of the linear stroke produced by a divider chain, and is coupled to waveform (2) by a diode with the intention of terminating the time-base stroke by hauling the Schmidt grid back to earth. In fact the impedance of the divider chain is too high to accomplish this at once and the two waveforms coalesce for a short time. There is no doubt in this display what the indentation in waveform (6) is due to, whereas a display of these waveforms with indeterminate d.c. levels would merely show the deformation in (6) as a mysterious feature because there is no corresponding deformation in (2).

Fig. 25 gives a practical indication of the speed and sensitivity of the machine with a record of an exceedingly well formed 0·1μsec pulse of 2V amplitude*.

Both of these are unretouched strobograms recorded on a background of $\frac{1}{4}$in squares, Figs. 12, 13 and 14, are also from strobograms but have been traced over with a thicker pen to permit considerable reduction in size.

There is insufficient space to adequately illustrate more specimen strobograms here but further instances may be pointed out in which waveform recording is particularly valuable. For example in the design of equipment it may be desirable to estimate just what improvement a certain modification has upon the output waveform.

The superposition of records with and without the modification affords a direct comparison. Again, in a triggered train of range marker pulses it is important that the pulses from the very beginning are all the same shape, since their centroid of area is the significant parameter. Using time shift to superpose these pulses in the record permits this comparison. In cases where the area under a waveform is significant (particularly in parametric plots such as *B-H* curves) a strobogram permits the direct application of a planimeter. Testing waveforms to pre-drawn tolerance boundaries is also a characteristic application. In all applications the merit of the method is not simply in revealing to the operator the condition of the test circuit but in enabling him to substantiate his report with graphic evidence.

Strobograms may be duplicated for reports by recording on flimsy graph paper with carbon backing paper to emphasize the pen track, and blueprinting the results. The apparent drawback to this arrangement is the loss of various colours that can be used in the original, but there is also a serious conceptual drawback in conceding a residual application for photographic techniques.

Acknowledgments

Thanks are due to the directors of E. K. Cole Ltd for permission to publish this article, and to Messrs. Parkinson and Cowan Limited, who on behalf of La Compagnie pour le production des Compteurs and Matèrials d'usinies à Gaz gave permission to reproduce the illustration of Hospitalier's 'Ondographe', also to those organizations and persons referred to in Part 1 who kindly corresponded on the subject of the history of the method.

Although the description in Part 2 of the article is based on the first prototype of the machine developed by Ekco Electronics Ltd, it should not be interpreted as a specification of that instrument.

* *Courtesy of Nagard Ltd.*

A New Marine Radar

A new marine radar, the 'Escort' type 601 has recently been introduced by the British Thomson-Houston Co. Ltd. This equipment has been designed to make the display interpret the situation instead of merely recording it and to make the handling of the set seem natural and easy. A few of the more important features are described below.

'Chart Plan' Presentation

Four forms of display can be selected to meet different situations. An important one is that in which the centre of the rotating sweep (i.e. the ship's own position) is moved across the picture in the direction of the heading marker, and at a speed corresponding to the ship's own speed. This endows the picture with a fixed frame of reference. Echoes from stationary objects appear as stationary echoes, while echoes from moving objects draw behind them 'tails' which show their aspect and true course. A repeater from a transmitting compass, and a pair of contacts on an electric log (or alternatively an estimate of speed set in by hand) are required to generate the translatory movements which correct for the ship's own movement, and stabilize the frame of reference of the display.

This form of presentation is called 'Chart Plan', because of its similarity in use to plotting on a chart. Its merits arise from the same cause; it gives at a glance information which could be obtained from a conventional 'relative' p.p.i. only by timed observations and the use of tables. The true course of other vessels and the identification of buoys and lightships by their absence of movement may serve as examples.

On the other hand some 'relative' data is valuable; in particular 'closest approach distance', which is readily estimated from a 'relative' p.p.i. by extending the tails of other vessels past 'own ship's position'. In order not to lose this facility the second form of Escort display is one in which the Chart Plan shift generators are temporarily arrested, so that the tails of echoes will turn and indicate their relative courses. The other displays are relative; either 'North Upwards' or 'Ship's Head Upwards'.

'Vantage Point' Off-Centring

With Chart Plan presentation the ship's own position moves across the face of the display, and periodically has to be reset. It is started from a point two-thirds of a radius away from the geometric centre of the display, and allowed to move through the centre and approximately one-third of a radius beyond, so that it will require resetting at intervals which depend on the scale of display in use, and the ship's speed.

Three problems arise in connexion with resetting; the right time for it to occur, the choice of position to off-centre to, and the speed of reaching it. In addition to choosing the time and place for resetting, the 'Vantage Point' system performs the operation quickly. The electronic reset reaches the Vantage Point before the aerial has rotated two degrees.

'Auto-Trim' Picture Alignment

Chart Plan presentation requires a compass repeater, and this is left connected when Escort is shut down. It is possible to arrange, therefore, that, on switching on, the heading marker is correctly orientated, regardless of the changes of course since the equipment was last in use. This is done entirely automatically, and the same circuit reorientates the picture 'Ship's Head Up' when that form of display is called for.

Bearing Marker Control

The bearing marker is a radial line, similar to the heading marker, painting once per revolution of the aerial. It is distinguished from the heading marker by the fact that the radius at which it begins to paint is the radius of the indicated range, whereas the heading marker paints from the origin.

This type of marker is notoriously awkward to use, since there is no visible response on the tube face to an adjustment of the control knob, until the aerial sweeps round again and paints in the new position.

The solution found for this problem in Escort is to control the direction of the bearing marker by a mechanical drive taken from the movable graticule in front of the c.r.t. It is arranged to be always parallel to the lines on the graticule, regardless of the point of origin.

Transistor Amplifier for Magnetic Tape and Drum Playback

By A. E. Bachmann*

Magnetic tapes and drums are frequently used as storage or transmission elements, containing the information in a digital form. This information is made available again by playing back the tape or drum through a magnetic head and an amplifier. The article discusses the problems involved in the realization of such an amplifier, when using transistors only. An analysis is given and the design procedure is worked out. A prototype amplifier has been tested, which operates from a playback head having an open circuit output voltage of more than 2mV. It is capable of driving three bistable multi-vibrators in parallel over a frequency range from 2 to 400 kc/s and a temperature range of 0°C to +70°C. The rise-time of the output pulse is less than 1 μsec.

(Voir page 248 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 254)

IN computers a magnetic tape or drum is frequently used as a storage or transmission element. The information, which is most often stored on the tape or drum in a digital form, can be made available again, by playing back the tape or drum through a magnetic head and an amplifier. This article covers an investigation made in order to design such playback amplifiers using generally available transistors. The general requirements are as follows:

In order that the proper head can be chosen from those which are commercially available, the necessary specifications must be calculated. The output of the amplifier must be capable of driving two bistable multivibrators in parallel.

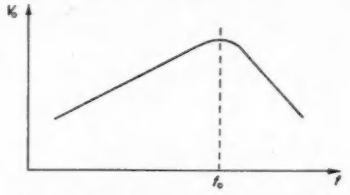


Fig. 1. Magnetic tape playback characteristic

Analysis

Playback Characteristics[1]

The open-circuit output voltage v_o of a magnetic tape playback head is given in Fig. 1.

According to the law of induction the head voltage v_o is:

$$v_o = -(d\Phi/dt) \cdot w = -w \cdot \Phi \cdot f \ldots\ldots\ldots (1)$$

where w is the number of windings in which the magnetic flux Φ changes according to the magnetization of the tape, here assumed to be of the frequency f. v_o inclines with 6dB/octave up to the frequency f_o. The subsequent fall off is due to self-demagnetization of the tape, the finite width of the gap in the playback head, which cannot be made infinitesimally small, as well as hystereses and eddy current losses in the head.

The equivalent circuit of the head is given in Fig. 2. It consists of an inductance L and a very small loss resistance r. Typical values for such a playback head are: (Potter Model 6404-7, 112 turns) $L = 1$mH, $r = 6\Omega$, $V = 7{\cdot}5$mV. Notice, that the voltage generator V is not constant, but increases with frequency at the rate of 6dB/octave.

If linearity of the playback system is of importance (e.g. in audio—and video playback system) equalizers which linearize the transfer characteristic must be applied.

* *PTT Res. Lab., Berne, Switzerland.*

Signal and Necessary Bandwidth

The information is stored in digital form on the tape, i.e. the tape is either magnetized or not magnetized. Thus when played back, the signal out of the head consists of the presence or absence of a pulse. The tape runs at a speed of 75in/sec for 15msec. It then stops and may be restarted after an unspecified delay. The signal pulses occur at a

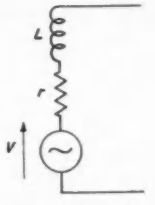


Fig. 2. Playback head

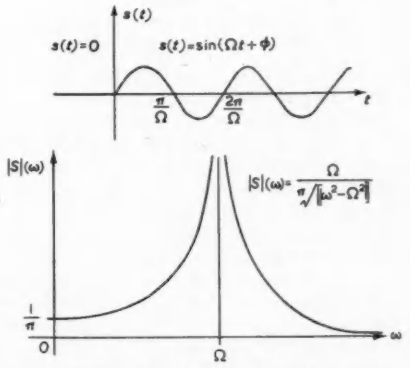


Fig. 3. Amplitude spectrum of a sine wave burst

maximum repetition rate of 15kc/s (90kc/s) or with a minimum spacing of 66·7μsec (11·1μsec)*. The exact waveform is not known but it is assumed that the pulses consist of a sine wave with third harmonic distortion. Because of the digital form, one bit of information consists of a single pulse of an approximately sinusoidal wave. The function $s(t) = \sin(\Omega t + \phi)$ has an amplitude spectrum $|S|$ as given in Fig. 3 for $\phi = 0$, when starting from zero at $t = 0$. In the case of a large third harmonic the spectral distribution will be different but will still have the same general shape. It can be seen that a very broad bandwidth is not necessary

* *See example under Amplifier Design.*

in order to amplify the signal coming from the head. A bandwidth from $\Omega/3$ to 3Ω is thought to be sufficient. Everything beyond that may improve the waveshape, but also decreases the signal-to-noise ratio due to the broader bandwidth.

The Three Amplifier Blocks

The signal coming from the head has quite a large amplitude of noise superimposed upon it. This noise appears because the tape does not run smoothly over the gap of the head, the distance between it and the head changing quite considerably. The signal may be thought of as having the amplitude 1 (see Fig. 4) with a possible fluctuation of $1 \pm a$, and a minimum signal-to-noise ratio of N_{min}, (i.e. the amplitude of the noise is never larger than $1/N_{min}$). Fig. 4 shows that in order to distinguish between noise and signal a threshold circuit must be adjusted to operate in the region

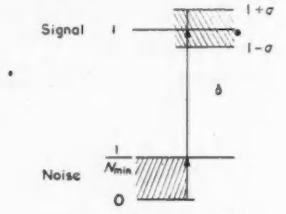


Fig. 4. Signal and noise

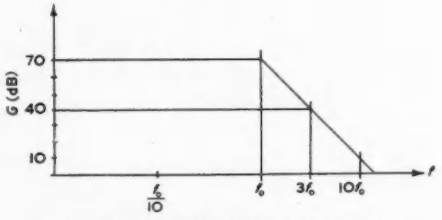


Fig. 5. Gain bandwidth of a three stage amplifier

δ between $1/N_{min}$ and $1 - a$. Since this region δ is very small in the original signal from the source (in the order of millivolts) it is necessary to amplify the signal by an amount A so that an ordinary non-linear element such as a diode can distinguish between the amplified noise $A \cdot 1/N_{min}$ and the signal A. After amplification the signal-to-noise ratio has not been changed (assuming the noise of the amplifier itself is considerably less than the tape noise), but the margin between signal and noise has been increased from δ to $A \cdot \delta$. It can be seen that a system using a fixed threshold level has certain limitations. It only operates as long as the fluctuation $\pm a$ of the signal is not too large. If the variation of signal amplitude is very great, a.v.c. would have to be applied to the bias of the threshold element.

Linear Amplifier and Input Considerations

The linear amplifier is necessary in order to bring the signal up to a level such that it may be easily distinguished from the noise, i.e. The margin $A \cdot \delta$ between signal and noise is made large enough so that a diode threshold element can be adjusted in such a way that only voltages which are higher than a certain specific value are considered as signals, everything lower than that as noise. The linear amplifier must have (a) stable gain and (b) the necessary frequency response.

(a) *Gain Requirements*

Assuming that the output of the linear amplifier is 1V across $3k\Omega$ for an input signal of 7·5mV, the required power gain is:

$$G = (V_o/V_i)^2 \cdot R_i/R_L = 1{\cdot}2 \times 10^4 = 40{\cdot}8\text{dB} \quad \ldots\ldots (2)$$

Output voltage: $V_o = 1V$

Input voltage: $V_i = 7{\cdot}5mV$

Load resistance: $R_L = 3k\Omega$

Input resistance: $R_i = 2k\Omega$ (for common-emitter stage)

Since the gain of a transistor stage is about 25dB it follows that a two stage amplifier will be sufficient. A gain control is necessary for eventual adjustment of the output level. If extremely stable gain is required, feedback would have to be applied.

(b) *Frequency Response*

Applying feedback to the amplifier also helps to increase the bandwidth as can be seen in Fig. 5. A three stage amplifier is shown having a low frequency power gain of 70dB

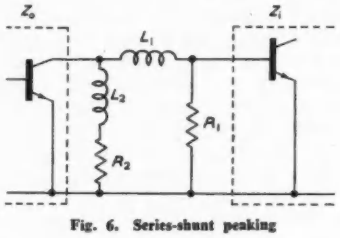


Fig. 6. Series-shunt peaking

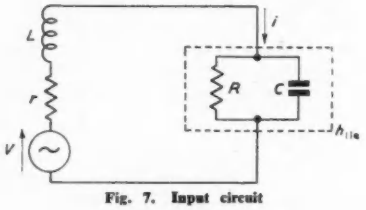


Fig. 7. Input circuit

and the -9dB point at f_o. If the gain of this amplifier is reduced by 30dB with the aid of feedback, then the cut-off frequency is made approximately three times larger. (Notice: a similar change occurs at the low frequency end). To build a three stage feedback amplifier of this type leads to problems of stability. It would have to be designed carefully by taking into account all the phase shifts due to transistors and coupling networks. Using generally available transistors (e.g. 2N123, 2N167) in the common emitter configuration, amplifiers having a flat response up to 100kc/s to 300kc/s can be built. If signals of higher frequencies have to be amplified, the design technique used is that which is adopted for video amplifiers[2]. For convenience Fig. 6 shows an example of interstage networks using series-shunt peaking.

(c) *Input Considerations*

The input circuit, given in Fig. 7, shows the playback head and the transistor represented by its input impedance h_{11e} (R and C in parallel).

The following transfer function $F = (i/V)$ is of interest and is calculated below:

$$F = (i/V) = \frac{1}{r + pL + [R/(1+pT)]}, \text{ with } p = j\omega \text{ and } T = RC \quad \ldots\ldots (3)$$

with the approximation $r \ll R$

$$L \gg CRr$$

equation (3) gives:

$$F = (1/R)\frac{1 + pT}{1 + P(L/R) + p^2CL} = (1/R)\frac{1 + pT}{1 + 2\zeta p\tau + p^2\tau^2} \quad \ldots\ldots (4)$$

from equation (4) it can be shown that

$$\left.\begin{array}{ll} T = RC & f_- = (1/2\pi T) \\ \tau = \sqrt{(LC)} & f_o = (1/2\pi\tau) \\ 2\zeta = (1/R)\ \sqrt{(L/C)} & Q = (1/2\zeta) \end{array}\right\} \quad \ldots\ldots (5)$$

the representation of equation (4) is given in Fig. 8.

The peak which occurs at f_o and which is due to the resonance of L and C, can be used to compensate the losses of the amplifier or head at the higher frequencies. From equation (5) it is possible for a given transistor, having a certain input impedance h_{11e} to determine the maximum permissible head inductance L, so that resonance occurs at the right frequency f_o:

$$L_{max} = \frac{1}{(2\pi f_o)^2 C} \quad \ldots\ldots (6)$$

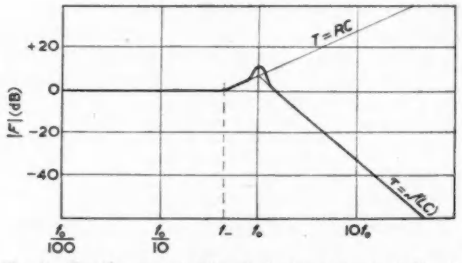


Fig. 8. Transfer characteristic of the input circuit of Fig. 7

The power transfer from the source to the first transistor is a maximum when source and input are conjugate matched, i.e.

$$r - pL = \frac{R}{1 + pCR} \quad \ldots\ldots (7)$$

Since equation (7) must hold for the real as well as for the imaginary part, two equations follow:

$$r = L/CR \quad \ldots\ldots (8)$$

$$r + \omega^2 LCR = R \quad \ldots\ldots (9)$$

from equations (8) and (9), the frequency ω_m of conjugate matching can be calculated as:

$$\omega_m^2 = \omega_o^2 (1 - L/CR^2), \text{ with } \omega_o^2 = 1/LC \quad \ldots\ldots (10)$$

In a typical case, where $L = 10^{-3}$H, $C = 10^{-9}$F, $R = 2 \times 10^3\Omega$, equation (10) gives:

$$\omega_m = \omega_o \sqrt{(1 - (1/4))} = 0{\cdot}87 \times \omega_o \quad \ldots\ldots (11)$$

a value which is close to ω_o itself. From equation (10) a value for R can be calculated:

$$R = \sqrt{\left(\frac{L/C}{1 - (\omega_m/\omega_o)^2}\right)} \quad \ldots\ldots (12)$$

if $(\omega_m/\omega_o) < 1/3$ equation (12) becomes

$$R \simeq \sqrt{(L/C)} \simeq 1\text{k}\Omega \quad \ldots\ldots (13)$$

So if R can be chosen after equation (13) the frequency ω_m where the source and the input are conjugate matched is appreciably lower than ω_o where there is resonance between L and C. How much lower it is cannot be said exactly, since control over R is not very good.

Threshold Element

The purpose of the threshold element is to pass only signals of greater than a certain magnitude, say C and block everything which is of a lower level. Fig. 9 shows a sinusoidal signal $V_A = V_{AO} + 2C\sin(\omega t + \phi)$ as it appears at the collector of an npn transistor, Fig. 10 showing the circuit. As long as the potential V_A of the collector is less than the d.c. potential V_{BO} of the voltage divider R_1, R_2, the diode D is biased backwards and no signal current flows into the next stage. The amplifier is blocked. As soon as the potential V_A of the collector exceeds V_{BO}, signal current

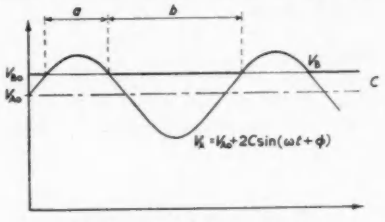


Fig. 9. Thresholding a sine wave

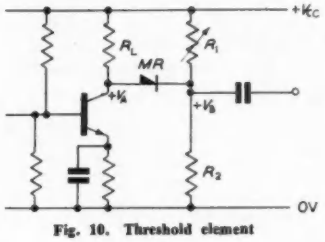


Fig. 10. Threshold element

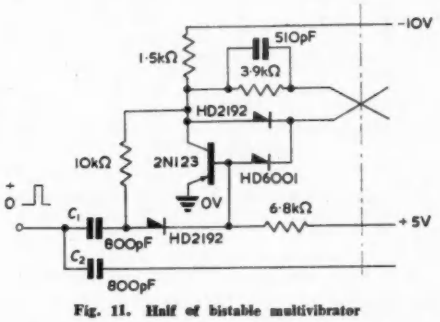


Fig. 11. Half of bistable multivibrator

flows into the next stage. The amplifier is unblocked. The amount of threshold C can be adjusted by varying the d.c. potential V_{BO} with the aid of the potentiometer R_1. As long as the magnitude of the signal is large enough, say larger than 0·5V, the characteristics of the diode are not important. If a smaller signal has to be thresholded (e.g. because the signal from the source is appreciably lower than expected) a high back resistance diode (e.g. HD2085) will give sharper clipping.

Non-linear Amplifier and Output Consideration

At the output, two bistable multivibrators of the type shown in Fig. 11 have to be triggered in parallel by means of positive triggers. To do so, the output must be capable of delivering a pulse of approximately 10V and 10mA with a rise-time of 2 to 3μsec. Since the length of the pulse is not very critical (it will be differentiated by the coupling capacitors C_1 and C_2 of the multivibrators) the non-linear amplifier can be designed with non-clamped saturated stages. The rise-time t_r of the common-emitter pulse amplifier in Fig. 12 is given by[2]:

$$t_r = \frac{1}{(1 - \alpha_{fb}) \cdot \omega\alpha_{fb}} \cdot \ln\left[\frac{1}{1 - \frac{0{\cdot}9\,(1 - \alpha_{fb})}{\alpha_{fb}}(I_c/I_b)}\right] \quad (14)$$

where α_{fb} = forward α_b

$\omega\alpha_{fb} = \alpha_b$ cut-off frequency in forward direction

I_b = driving current at the base

I_c = saturation current

Thus for a given transistor, the rise-time can be made shorter by decreasing the saturation current I_c and increasing the driving current I_b at the base.

Amplifier Design

After the analysis of the amplifier, the design of any particular playback amplifier will be relatively simple. For the purpose of this development, the following two types are

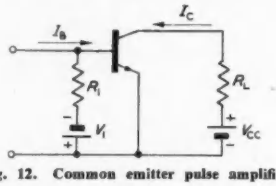


Fig. 12. Common emitter pulse amplifier

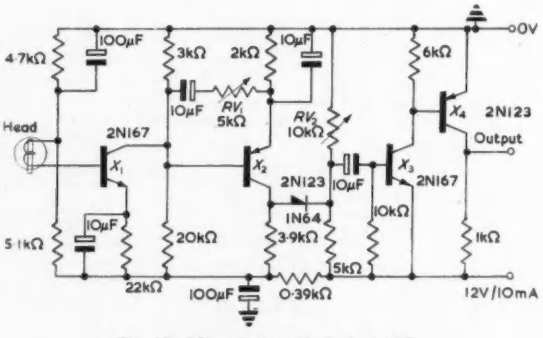


Fig. 13. Magnetic tape playback amplifier

of interest:

Type	(a) Tape Playback	(b) Drum Playback
Pulse repetition rate	15kc/s	90kc/s
Head inductance	1mH	50μH
Head loss resistance	6Ω	
Open-circuit output voltage	7·5mV r.m.s.	20mV
Number of 'flip-flops' to be driven in parallel	2	
Threshold level	50 per cent	

First equation (6) has to be checked in order to find out if the first stage can be an ordinary common-emitter stage for the given heads. Such a stage has a shunt capacitance C of approximately 0·001μF. If the resonance frequency is chosen as three times the pulse frequency, it can be seen that in both cases the given inductance of the head is less than the required L_{max} given by equation (6).

Both amplifiers can be built without using feedback or peaking networks. As outlined in the analysis two stages are sufficient for the linear amplifier. This will give some reserve of gain in case (a) and more in case (b). Fig. 13 shows the circuit which can be used for both cases. This circuit has actually been built and tested.

The linear amplifier makes use of the npn, pnp symmetry for direct coupling. Potentiometer RV_1 is the volume control. Potentiometer RV_2 sets the threshold value. To set the threshold level the following procedure is recommended:

(1) Feed in the amount of signal available as a sine wave.

(2) Adjust the potentiometer RV_1 so that the signal level at the collector of transistor X_2 is in the order of 1V r.m.s., (i.e. for input signals below 20mV r.m.s. put RV_1 at maximum).

(3) Look at the waveform after the diode on an oscilloscope and adjust the threshold potentiometer RV_2 so that proper thresholding is achieved. The ratio of b/a in Fig. 9 tells how much of the sine wave comes through (e.g. 50 per cent for $b/a = 2$).

Assuming that the input-current into the base of X_3 is approximately 0·25mA and the short-circuit current gain α_e

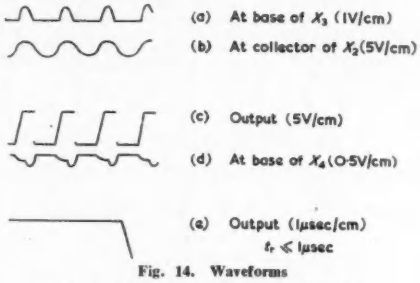


Fig. 14. Waveforms

Input: 7·5mV r.m.s. sine wave of 15kc/s
Volume (RV_1) at maximum
Threshold (RV_2) at 50 per cent

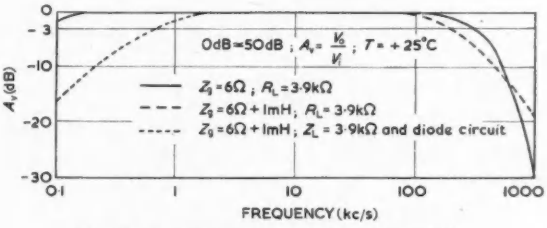


Fig. 15. Frequency response of the linear amplifier

of each transistor is 20, the collector current of X_3 is 5mA. Since the saturation current of X_3 is 12V/6kΩ = 2mA, 3mA flow into the base of X_4, giving a collector current in X_4 of 60mA. Deducting the saturation current of 12mA, this means that approximately 48mA are available to drive the flip-flops.

For applications where repetition rates up to 100kc/s may be encountered the last two stages can also be made direct coupled. Since the storage time is too long for higher repetition rates, a simple differentiating RC network must be inserted. With this addition the amplifier operates with repetition rates up to 400kc/s.

Measurements

Fig. 13 gives the final circuit of the amplifier as it has been designed and tested.

Fig. 14 shows the different waveforms at certain points of the amplifier when the input signal is a sine wave of 15kc/s.

In Fig. 15 the frequency response of the linear amplifier is given. The playback head was represented by a coil of 1mH inductance. Resonance between this inductance and the input capacitance of the first stage occurs at about 300kc/s.

Fig. 16 gives the rise-time as a function of the amplitude of the input signal. A relative amplitude of 1 means that amount of input signal (e.g. 7·5mV r.m.s.) such that 50 per

cent is cut off by the threshold element. In an ideal case any signal having a magnitude of less than 0·5 should not come through, thus t_r would be infinite. Since the diode characteristic is not ideal and the average of the impedance looking into the diode circuit depends on the threshold level, infinite rise-time occurs at a relative amplitude of 0·3 rather than 0·5.

In Fig. 17 the voltage gain of the first two stages is plotted as a function of temperature. It is flat within 3dB from +10°C to +70°C. Below 0°C it drops off more rapidly.

The amplifier was capable of driving in parallel, three bistable multivibrators of the type shown in Fig. 11. It worked over a temperature range from 0°C to +70°C. Using a sine wave input, it was possible to trigger the multivibrators from 2kc/s to 400kc/s. Interchanging transistors did not affect the proper working of the amplifier.

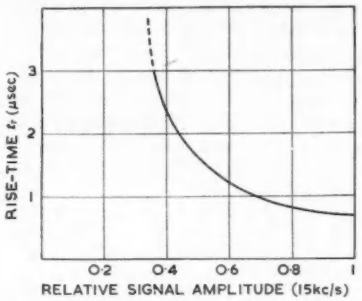


Fig. 16. Rise-time against input amplitude

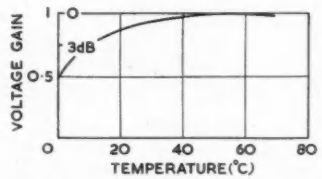


Fig. 17. Linear voltage gain against temperature

Acknowledgments

The author is indebted to the Electronics Laboratory of the General Electric Company, Syracuse, N.Y., where he had the opportunity of carrying out the work described.

Appendix

Equalized Linear Amplifier

The foregoing investigation is based on the assumption that all the pulses appearing at the input of the amplifier (base of X_1) have the same amplitude within the tolerated fluctuation limits $\pm a$. This is necessary if the information to be transmitted consists of both single pulses and sequences of pulses. When a fixed threshold element is used, it is very important that each pulse reaches the diode with the same amplitude so that the threshold level for all of them will be the same.

If the above assumption does not hold and the amplitude of the pulses from the playback head are dependent on the repetition rate, the response of the linear amplifier has to be shaped by means of equalizing networks.

First the playback characteristic of the system involved (drum or tape) has to be measured in order to find the slopes of the response and the frequency f_o as indicated in Fig. 1. Once this is known, an equalizing network can be found which together with the amplifier gives a flat overall response.

A typical example is that shown in Fig. 18, where the transistor is by-passed with an RC-network. The transfer function $F = i_2/i_1$ given by

$$F = i_2/i_1 = \frac{Z}{Z + h_{11e}} = \frac{(1+pT_1)\,.\,(1+pT_2)}{(1+pT_1)\,.\,(1+pT_2) + pR_2C_1} \quad . \quad (15)$$

where $T_1 = C_1R_1$; $T_2 = C_2R_2$; $p = j\omega$. In order to make F the image of the playback characteristic over the necessary frequency range from $f-$ to $f+$ it can be shown that the following equations must hold:

$$R_1C_1 = R_2C_2 = T_o = 1/2\pi f_o \quad \ldots\ldots\ldots \quad (16)$$

$$C_1 \simeq KC_2, \text{ where } K = f_o/f- \quad \ldots\ldots\ldots \quad (17)$$

R_2 is given by the transistor and its bias resistors. From equation (16) C_2 can be found. Part of C_2 will consist of the input capacitance of the transistor. The choice of K depends on the system to be used and can be as high as 100. Equation (17) gives the value

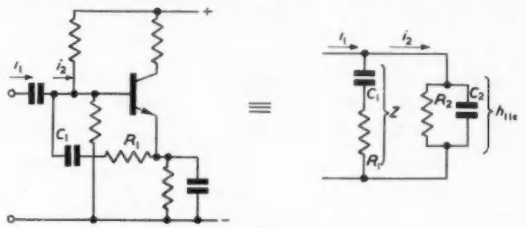


Fig. 18. Equalizing stage

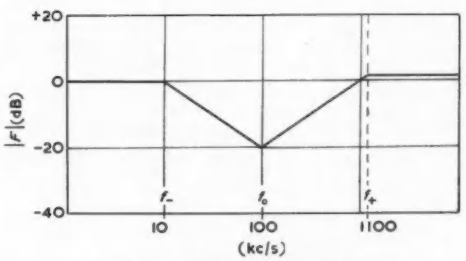


Fig. 19. Equalizing characteristic

of C_1 from K and C_2 and equation (16) again gives R_1 from C_1 and T_o.

Example: $R_2 = 2k\Omega$

$f_o = 100kc/s$

$f- = 10kc/s$

The calculations lead to:

$C_2 = 800pF$

$K = 10$

$C_1 = 0{\cdot}008\mu F$

$R_1 = 200\Omega$

Fig. 19 shows the absolute value of the transfer function $F = i_2/i_1$ for the above example. The upper frequency $f+$ is given by $f+ = 1/2\pi\tau_2$, where τ_2 is

$$\tau_2 = T_o + (R_2C_1/2) - \sqrt{[T_o\,R_2C_1 + (R_2C_1/2)^2]} \simeq 0{\cdot}14\mu sec \quad \ldots\ldots\ldots\ldots \quad (18)$$

$$f+ = 1/2\pi\tau_2 \simeq 1{\cdot}1Mc/s \quad \ldots\ldots\ldots \quad (19)$$

Since the equalizing network introduces a loss, additional stages have to be used in the amplifier in order to meet the gain requirements.

REFERENCES

1. Rint C., Hanbuch fuer Hochfrequenz-und Elektrotechniker, Band 2 and 3.
2. Shea, R. F. ed. Transistor Circuit Engineering, (Wiley & Sons, 1957).

A Simple Very Low Frequency Oscillator

By J. F. Young*, A.M.I.E.E., A.M.Brit.I.R.E.

The usual methods of amplitude stabilization of resistance-capacitance oscillators are frequency sensitive. In the simple oscillator described a Zener diode limits the amplitude and the resulting harmonics are filtered out by a selective circuit which also controls the frequency of oscillation. A reasonable waveform can therefore be obtained even at very low frequencies.

(Voir page 248 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 254)

IT is usual to add some form of amplitude limitation to valve oscillators in which the frequency is controlled by resistance-capacitance selective circuits. This is required for two reasons, firstly in order to maintain a constant output voltage irrespective of load variations, and secondly to prevent build-up of oscillation to the point where overloading causes excessive harmonic distortion to appear. These are often conflicting requirements, since when the load is heavy, a system designed to maintain a constant mean or r.m.s. value of output voltage can cause amplitude distortion to appear. The two requirements should therefore be met by separate control circuits. In many cases it is not necessary to have a low output impedance and amplitude limitation is only required in order to avoid distortion.

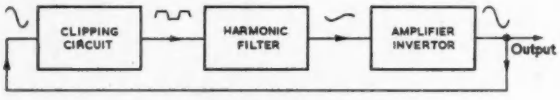


Fig. 1. Block diagram of oscillator

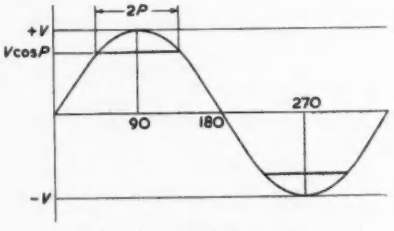


Fig. 2. Clipped sine wave

The methods generally used fall into two classes. The first class uses some form of feedback automatic gain control, in which the voltage at some point in the oscillator is measured and used to control the gain of the oscillator loop. The a.g.c. action is of necessity slow, and difficulties are encountered where the oscillator must cover a wide frequency range.

The second class of amplitude limitation makes use of thermal non-linear elements, such as lamps or thermistors, in which the slope resistance depends on the r.m.s. value of the current flowing through the device. These make very simple circuits possible, but they have two disadvantages. The fact that they are thermal devices makes them sensitive to ambient temperature, though this can be allowed for in the design. A more serious disadvantage is that unless special steps are taken to slow down the response, thermal elements are not suitable for use in v.l.f. oscillators since they would respond to instantaneous rather than r.m.s. amplitudes.

Since existing methods of stabilization are frequency sensitive, the possibility of using an amplitude limiter (or clipper) is worth exploring. Such a clipper is not sensitive to frequency, but it produces harmonic distortion. However, the selective circuit of an oscillator can be used both to control the oscillation frequency and to filter out harmonics produced by the clipping circuit. A block diagram of an oscillator utilizing this principle is shown in Fig. 1. Here the output sine wave is fed back and passed through the clipping circuit where the peaks are removed. The filter then removes most of the harmonic content and the resulting sine wave is amplified.

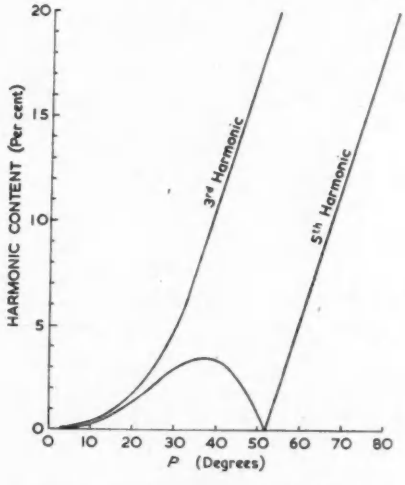


Fig. 3. Harmonic content of clipped sine wave

A sine wave $V \sin L$ is shown in Fig. 2 clipped at an amplitude of $V \cos P$, the angle of clipping being $90° \pm P$.

Fourier expansion of this waveform gives:—

$$2V/3{\cdot}14\ [(3{\cdot}14/2 - P + \tfrac{1}{2}\sin 2P)\sin L$$
$$+(\tfrac{1}{2}\sin 2P - \tfrac{1}{4}\sin 4P)\tfrac{1}{3}\sin 3L$$
$$-(\tfrac{1}{4}\sin 4P - 1/6\sin 6P)\,1/5\sin 5L$$
$$+ \ldots\ldots\ldots\ldots\ldots\ldots\ldots]\ldots.(1)$$

The percentage third and fifth harmonics are plotted in Fig. 3. It will be noticed that the 5th harmonic disappears

* *The General Electric Co. Ltd, Birmingham.*

completely at approximately $P = 52°$ when the wave is clipped down to about 0·6 of its peak amplitude. The third harmonic is then about 16 per cent of the fundamental, or 16dB down.

As the amount of clipping increases, the coefficients approach those for a square wave of very small amplitude, as would be expected.

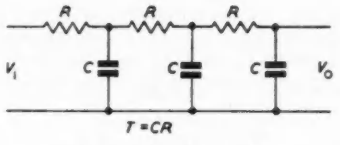


Fig. 4. Selective circuit

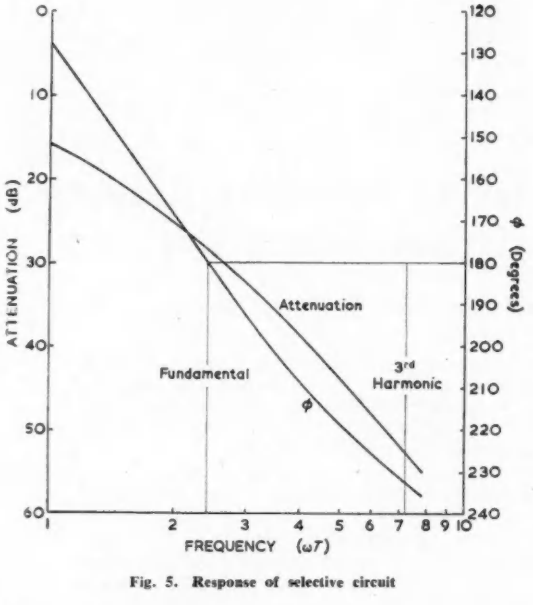


Fig. 5. Response of selective circuit

In order to obtain a reasonable waveform, the third harmonic content of the clipped wave must be attenuated by some tens of decibels below the fundamental. This cannot be done with the Wien bridge or the parallel-T networks commonly used in oscillator circuits since these give a ratio of only about 6dB between the frequency of oscillation and the third harmonic. Multiple ladder networks can give better results, and can be used in quite simple oscillator circuits.

The ladder circuit shown in Fig. 4 has a frequency response of the form:—

$$V_o/V = \frac{1}{1 - 5\omega^2 T^2 + j\omega T (6 - \omega^2 T^2)} \quad \ldots\ldots \quad (2)$$

It can be used in an oscillator circuit, since it gives a 180° phase shift at a frequency where $\omega T = 2{\cdot}45$. The response is plotted in Fig. 5. The attenuation at $\omega T = 3 \times 2{\cdot}45$ is about 24dB greater than that at the fundamental frequency, and the resulting third harmonic distortion when used in conjunction with the clipped wave mentioned would be 40dB down, or 1 per cent.

The type of selective circuit mentioned has been widely investigated and used in oscillators, and there are many references to it[1]. Some preliminary tests on such a circuit were carried out with the arrangement of Fig. 6 working at 50c/s. An EW77 Zener diode was used to clip the waveform. This has the advantage that it can provide an effective 3V bias for the grid of a valve at the same time as it clips the waveform, so there is no necessity for other biasing arrangements.

The output amplitude was reasonably constant at about 0·23V peak-to-peak for input amplitudes down to about 10V peak-to-peak.

The amplifier gain required for use in an oscillator is a minimum of about 30dB, as will be seen from Fig. 5. The amplifier must be designed so that it will not saturate with

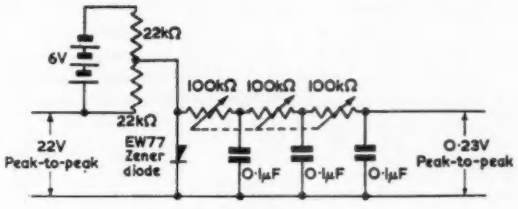


Fig. 6. Test circuit

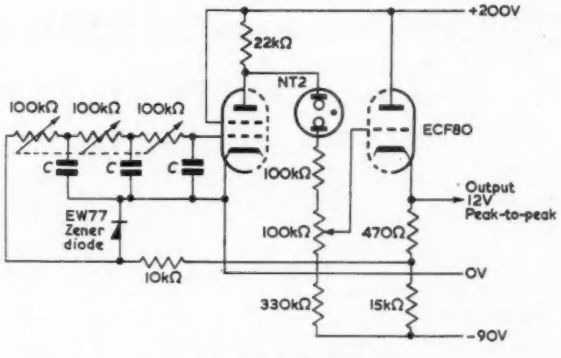


Fig. 7. The simple oscillator

several times 0·23V peak-to-peak input, while providing more than the specified 10V peak-to-peak output. This is not difficult, and a suitable circuit is given in Fig. 7.

The circuit uses an ECF80 triode-pentode valve as an amplifier and cathode-follower. It is entirely d.c. coupled so that there is heavy d.c. negative feedback in the absence of the Zener diode. This ensures that the Zener diode cannot be biased to a condition where it can prevent the build-up of oscillation. The Zener diode provides the bias for the pentode section and clips the waveform. The output obtained is about 12V peak-to-peak, and since it is taken from the cathode-follower, the output impedance is reasonably low. No difficulty is encountered in starting oscillation and there are no transient effects when tuning.

More complicated versions of this basic arrangement could give improved results. These would involve the use of a four gang tuning resistor, or preferably capacitor, and an extra cathode-follower to reduce the source impedance seen from the selective circuit. The latter addition would make it possible to reduce the loading of the output cathode-follower by the clipping circuit. In the simple circuit it is necessary to compromise to keep the clipping

circuit source impedance low, while not excessively loading the cathode-follower by the Zener diode.

If the variable resistors are made too small compared with the source impedance, oscillation ceases, since the gain is reduced. Variation of the capacitors rather than the resistors, removes this effect, as does the addition of fixed resistors in series with the variable ones to provide a definite minimum value.

The circuit is based on the deliberate introduction of amplitude distortion at a point in the loop where it can have only a small effect on the output waveform. In the normal oscillator of this type, the amplitude distortion which occurs, accidentally, if no amplitude stabilization is employed, is in such a position that the output is distorted. The circuit given is of particular use as a very low frequency generator. More complicated versions should have a wider use, having the advantage over other methods of amplitude stabilization that transient effects are avoided. It should be noted that there is no attempt to maintain the output voltage constant, and this will vary if the gain of the valves varies. However, this will have little effect on the output waveform.

The circuit shown oscillates at frequencies from 100kc/s down to one cycle per minute. The upper limit is caused by stray capacitance, while the lower limit is mainly determined by the physical size of the capacitors required. If still lower frequencies are required, the common ends of the capacitors in the selective circuit should preferably be taken to a slightly negative voltage. This would avoid the heavy current which would otherwise be taken by the pentode while the capacitors were initially charging up to the correct negative mean running voltage. It would also make the oscillation build up more rapidly after switching on.

Acknowledgment

The author wishes to thank the General Electric Co. Ltd for permission to publish this article.

REFERENCE

1. SHAW, J. C. The Design of Phase Shift Oscillators and Filters (Bibliography). *Electronic Engng. 28*, 216 (1956).

A Stroboscopic Method of Making Frequency Response Measurements on Small Electromechanical Devices

By M. Shepherdson*, B.Sc. and R. Walters*, A.M.I.Mech.E.

A method is described for making frequency response measurements on small electromechanical devices using a travelling microscope and a stroboscopic lamp. Apart from a simple pulse amplifier and phase shifting network, which is described, the apparatus needed is available in most well equipped electrical laboratories. The method involves no loading of the test component and allows amplitude measurements well below ·001in to be taken.

(Voir page 248 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 254)

FREQUENCY response measurements on small electromechanical components are complicated by the fact that it is impossible to attach a pick-off to the moving member without loading it mechanically. Inductive or capacitive proximity meters can be used which exert a negligible force on the moving part, but these require calibration on each test piece and usually involve the complications of a modulation system. An optical method of measurement has been used which has the advantages of simplicity, accuracy and flexibility. Apart from a simple pulse amplifier and phase shifting network the apparatus needed is available in most well equipped electrical laboratories. In a typical application the responses of all the moving parts of an electro-hydraulic servo system were determined. These included a torque motor driving a pilot valve, the main valve and a hydraulic jack. Amplitudes at the pilot valve were measured down to 0·001in and the jack movements were up to 0·5in. Frequencies were from 10c/s to 250c/s. It is only necessary that the part undergoing test be visible.

The Method

The test component is excited at the desired frequency from an oscillator through an appropriate amplifier and the moving element examined through a travelling microscope with cross hairs or an eyepiece scale. Light is provided by a stroboscopic lamp triggered by the oscillator. Between the oscillator and lamp a phase shifter is interposed, capable of continuous phase shift up to 360°, also a pulse forming amplifier. In the latter the sinusoidal input is squared and differentiated to give a sharp pulse each time the signal passes through zero. The circuit is arranged to apply all the pulses to the stroboscope in the same sense, thereby giving two flashes per cycle, but a switch permits the suppression of every second pulse.

Using one flash per cycle, the operator can see one stationary image in the field of the microscope. If he turns the phase control steadily through 360° the image goes through one cycle of movement, passing through the centre twice, in opposite directions, and reaching each extreme once. Under double flash illumination two images are seen. In this case when the phase control is advanced through 360° the two images merge into one twice and reach extreme separation twice. The amplitude can be measured directly, being half the maximum separation of the images. For small amplitudes, the eyepiece scale is used together with a high power objective if necessary. Measurements of large amplitudes are made with the calibrated traverse mechanism of the microscope.

The phase of the motion relative to the oscillator is read off the calibrated phase shifter when the images are in coincidence. There is an ambiguity of 180° owing to the fact that the images merge twice per rotation of the phase

* *Sperry Gyroscope Company Limited.*

shifter. If the performance of the device is not already known with sufficient accuracy to resolve the ambiguity, the correct coincidence must be selected after examination under single flash illumination. The two nulls can be distinguished under single flash operation, because at one null as the phase is advanced the image moves in one direction whereas at the other null advancing the phase moves the image the other way. Reference to the very low frequency performance will reveal which is the correct null to use.

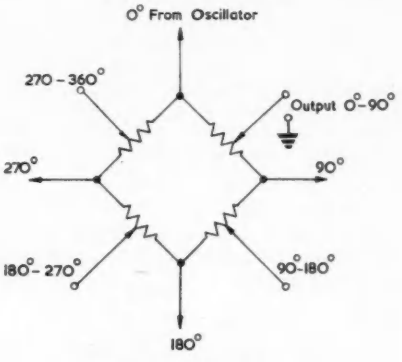


Fig. 1. Phase shifter

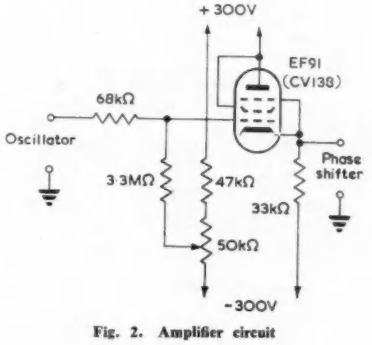


Fig. 2. Amplifier circuit

Electronic Circuits

In order to make a phase shifter independent of frequency it is necessary to have a polyphase source. The Solartron transfer function analyser has a four phase oscillator which has been found to be suitable. Four potentiometers are connected between the line terminals as shown in Fig. 1. Each potentiometer has a range of 90° and a four way switch selects the desired quadrant. It can be shown that such a phase shifter obeys the law

$$X = \frac{1}{1 + \cot \phi}$$

where X is the fraction of the potentiometer taken out and ϕ is the phase shift.

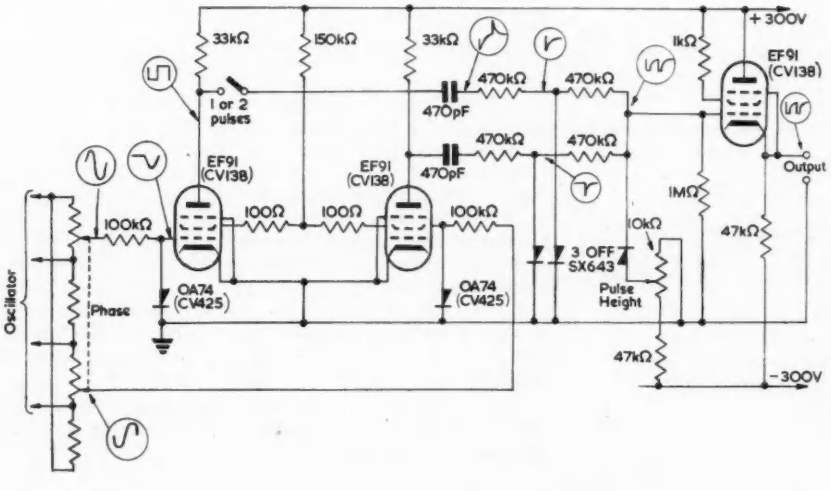
The Solartron oscillator has two terminals at a high impedance level. To prevent loading the oscillator and to retain balance, four isolating stages as shown in Fig. 2 were interposed between the oscillator and the phase shifter.

Fig. 3 shows the amplifier circuit used. A push-pull signal is taken from the phase shifter using a ganged pair of potentiometers. This is applied to the grids of a pair of valves run to saturation, positive grid current being diverted through diodes. The square waves are differentiated and the positive pulses clipped off before addition at the grid of the output valve. A further limiter is included to cut all the pulses to a uniform height of about 50V. These pulses were used with a Dawe Stroboflash.

Conclusion

In order to achieve accuracy with the method described the pulses must have a fast rise-time and be accurately placed on the timing wave. If they are not exactly 180° apart it becomes impossible to bring the two images to coincidence and there is a small error in amplitude measurement. Any delay in the lamp triggering circuit introduces errors to the extent that it is indeterminate. A photocell and amplifier capable of displaying the light flashes on an oscilloscope have been found to be very useful for measuring time lags in the system. With the apparatus described a lag of about 0·5msec was detected and allowed for in the higher frequency measurements. The lower limit of amplitude that can be detected is governed by microscope technique. Down to about ·001in minor surface blemishes on the moving part provide features on which measurements can be made. Below this level special fine marks must be provided possibly by polishing and etching. When a high power objective is used to measure very small amplitudes the system would be improved by introducing the light through a vertical illuminator. The upper frequency limit is determined by the duration of the lamp flash. A high energy short duration flash not only allows a fast repetition rate by also gives sharp focusing.

Fig. 3. Isolating amplifier



REGULATED POWER SUPPLIES

By D. J. Collins*, B.Sc.(Eng.), A.M.I.E.E., and J. E. Smith*, B.Sc.

Regulated, or stabilized, d.c. power supplies are required for a number of purposes. In this article the various types of regulators are briefly reviewed and the closed loop series stabilizer is dealt with in some detail. The design problems of this type of unit are considered and particular reference is made to the loop stability. In an Appendix the design of a typical unit is detailed.

(Voir page 248 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 254)

As the use of precision circuits increases, the necessity for better power supplies becomes apparent. At some time, the need may be felt for a d.c., h.t., supply having one or more of the following features:

(a) Good regulation, i.e. low internal resistance and, in some instances, low internal impedance.
(b) Good stability, i.e. stable output voltage despite mains fluctuations, temperature changes, etc.
(c) Low ripple and noise content.
(d) Ability to vary the h.t. voltage without detriment to any of the above features.

The demand has been met with a variety of devices, some of which are termed regulated power supplies and others stabilized power supplies. Many of the devices provide both good regulation and good stability, and throughout this article the term regulated supply will be used to imply good regulation or good stability.

Definitions

At this stage, it is necessary to define some of the terms used in specifying a regulated power supply.

Output Voltage

Although this seems rather obvious, the designer will require to know if variable supplies are required, and if not, to what accuracy the supply voltage is required to be set. It is also necessary to know if the supply will be 'floating', or will have a terminal connected to ground.

Output Current

The current range must be specified, and the supply must cater for the peak current conditions and not merely for the quiescent level.

Source Resistance

This is the internal resistance of the supply which, in some designs, can be made as low as ·001Ω.

Source Impedance

This is the internal impedance of the supply, and it is usual to stipulate some frequency limit.

Ripple and Noise Level

This is usually specified in millivolts peak-to-peak. Quite often, the content has a complex waveform, and an oscilloscope measurement is to be preferred.

Stability

Many factors will cause output voltage variations. The most obvious is possible variations in the mains voltage, and it is usual to specify a stabilization ratio or factor which is defined as:

$$\frac{\text{Percentage change in mains voltage}}{\text{Resultant percentage change in output voltage}}$$

Power Input

The overall range of mains voltage and frequency must be specified, and it is usual to design for a limited voltage variation on a nominal input. This limited variation is usually taken as ±7 per cent on electronic supplies, this figure being based upon valve manufacturers' permissible heater voltage variation.

Miscellaneous

Other parameters or features which are required to be specified include environmental conditions, metering, fusing, switching, and connexions.

Simple Stabilizing Elements

The first attempts to provide regulated supplies were made using gas-filled stabilizer tubes. The tubes provide a simple solution, but have limitations. In general, only supplies having voltages greater than about 70V and currents less than 50mA can be handled in this manner.

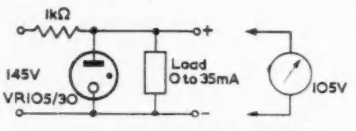


Fig. 1. Simple gas filled regulator

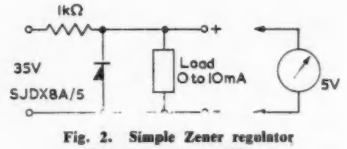


Fig. 2. Simple Zener regulator
Source resistance 20Ω
Stabilization factor 7 : 1
Ripple reduction 50 : 1

A typical circuit is shown in Fig. 1. This circuit provides a source resistance of approximately 60Ω, has a stabilization factor of 14:1, and provides a ripple reduction of 20:1.

Of recent years, a lower voltage element, the Zener diode[1] has achieved some prominence. These diodes make use of the breakdown state of a silicon junction diode when subjected to a reverse voltage. The slope resistance in the breakdown condition is dependent upon the turnover voltage of the particular diode. The temperature coefficient, which is significant, varies from a negative value to a positive value, the crossover point occurring in the 5V region. Improvement in temperature coefficient can be effected by using a combination of diodes but with resultant increase in slope resistance.

Fig. 2 shows the circuit of a Zener regulator, the parameters of which are detailed. This type of circuit is finding favour as a reference level for use in transistor power supplies.

There are available a number of non-linear components, e.g. thermistors, which can be used as stabilizing elements in power supplies.

* *Solartron Research and Development Ltd.*

Hard Valve Voltage Regulators

Hard valve circuits have overcome many of the disadvantages of the gas-filled stabilizer. In general, the control is carried out by the hard valve circuit utilizing the stabilizer tube purely as a stable voltage reference.

There are two main types of circuit configuration, the shunt type and the series type, the latter being more common. The series type gives a lower source resistance, and is more suitable for high and variable voltage supplies. The shunt regulator is more suitable for constant voltage, fixed load supplies. Fig. 3 shows a simple shunt regulator, and indicates the basic parameters.

In view of its wider application and superior performance, only the series type circuit will be considered in detail.

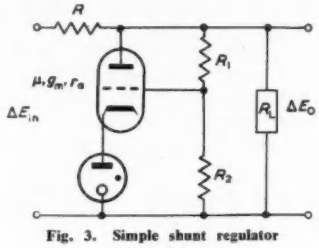


Fig. 3. Simple shunt regulator

$$R_o = \frac{R}{1 + (R/r_a) + \beta R g_m}$$

$$\frac{\Delta E_{in}}{\Delta E_o} = 1 + (R/R_L) + (R/r_a) + \beta g_m R$$

$$\beta = \frac{R_2}{R_1 + R_2}$$

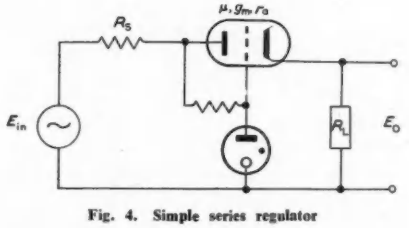


Fig. 4. Simple series regulator

Simple Series Regulator

The series regulator is basically a simple cathode-follower, to the input of which a stable reference level is applied (see Fig. 4). Assuming a perfect reference source, i.e. constant voltage and zero internal resistance, this configuration gives a source resistance R_o, which is the source resistance of a cathode-follower,

$$R_o \simeq \frac{r_a + R_s}{\mu}$$

The stability figure $\Delta E_o/\Delta E_{in} = \dfrac{R_s + r_a}{R_L} + (1 + \mu) \simeq \mu$ when μ is large.

The circuit has the limitation of having its output closely tied to that of the reference. From the formulae, it is apparent that valves having high μ and low r_a give better performance. A typical valve, the A2134, has $\mu = 10$ and $r_a = 835\Omega$. Valves designed for this application are required to operate at high currents with low anode voltages, and in more complex regulators this is of prime importance.

For a supply having a source resistance of less than 10Ω, the single valve cathode-follower is not adequate. Parallel combinations can produce lower figures, but there are more economic ways of producing a better performance.

Closed-Loop Regulator

The performance of the simple cathode-follower can be vastly improved by means of closed loop feedback with a d.c. amplifier. A simple closed-loop system is illustrated in Fig. 5, together with its equivalent circuit.

In analysing the performance of this circuit, the following assumptions are made:

(a) That the gain of the pentode amplifier is $-M$.

(b) That the grid-cathode signal appearing at the series valve is V_g.

(c) That the current drain in the divider chain, R_1, R_2 is negligible compared with the load current.

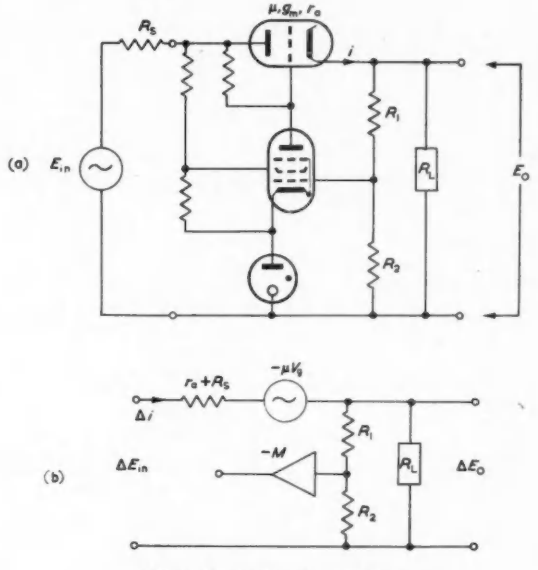


Fig. 5. Improved series regulator

(d) That the transmission of the chain is

$$\beta = \frac{R_2}{R_1 + R_2}$$

Consideration of the equivalent circuit gives the following equations:

$$\Delta E_{in} = \Delta i\,(r_a + R_s) - \mu V_g + \Delta E_o \quad \ldots\ldots\ldots \quad (1)$$

$$V_g = -M\,(\beta \Delta E_o) - \Delta E_o \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$\therefore \Delta E_{in} = \Delta i\,(r_a + R_s) + \mu \Delta E_o (1 + \beta M) + \Delta E_o \quad \ldots \quad (3)$$

From equation (3):

$$\Delta i = \frac{\Delta E_{in} - \Delta E_o\,[1 + \mu\,(1 + \beta M)]}{r_a + R_s} \quad \ldots\ldots\ldots \quad (4)$$

But $\Delta E_o = \Delta i R_L$

Substituting in equation (4)

$$\Delta E_o = \frac{\left\{\Delta E_{in} - \Delta E_o\,[1 + \mu\,(1 + \beta M)]\right\} R_L}{r_a + R_s}$$

$$\therefore \Delta E_{in}/\Delta E_o = \frac{r_a + R_s}{R_L} + \Big(1 + \mu\,(1 + \beta M)\Big)$$

In practice, the stability figure $\Delta E_{in}/\Delta E_o$ approximates to $\beta M \mu$

Thus, the introduction of an amplifying stage has improved the stability figure by a factor, βM. βM is usually large and is termed the 'loop gain' of the system.

It can also be shown, that for this type of system

$$R_o = \frac{r_a + R_s}{1 + \mu(1 + \beta M)} \simeq \frac{r_a + R_s}{\beta M \mu}$$

and thus the source resistance of the series valve has also been decreased by the factor βM. It is obvious that R_s is not usually purely resistive, since the power source can contain a choke and/or capacitor filter.

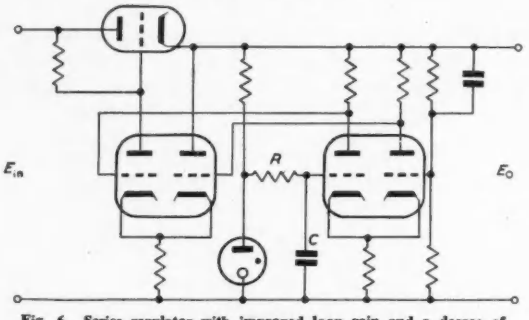


Fig. 6. Series regulator with improved loop gain and a degree of drift correction

type shown in Fig. 5, having an output voltage 250V, dependent upon an 85V reference tube, then this signal produces an output variation of approximately 0·3V or 0·1 per cent of the output. This then implies a maximum stabilization factor of 100 : 1.

Some of the above disadvantages can be minimized by the use of more complex circuits.

Improved Closed-loop Regulator

Fig. 6 shows a widely used circuit which has relatively good performance. For analysis purposes, this is identical with the circuit of Fig. 5, the composite gain of the cathode-coupled stages being defined as $-M$.

The following improvements over Fig. 5 should be noted:—

(a) The reference tube is fed from the output rail and no longer has valve cathode current flowing in it, and thus tends to approach the performance of an ideal reference source. The high impedance loading of the grid circuit makes negligible current demand, and facilitates the use of a simple *RC* filter to remove the inherent tube noise.

(b) The use of cathode coupled amplifiers provides a measure of drift cancellation, and careful design can produce an improvement of about 4 : 1. Despite this improvement, contact potential drift is still the main factor in determining the stability of the output.

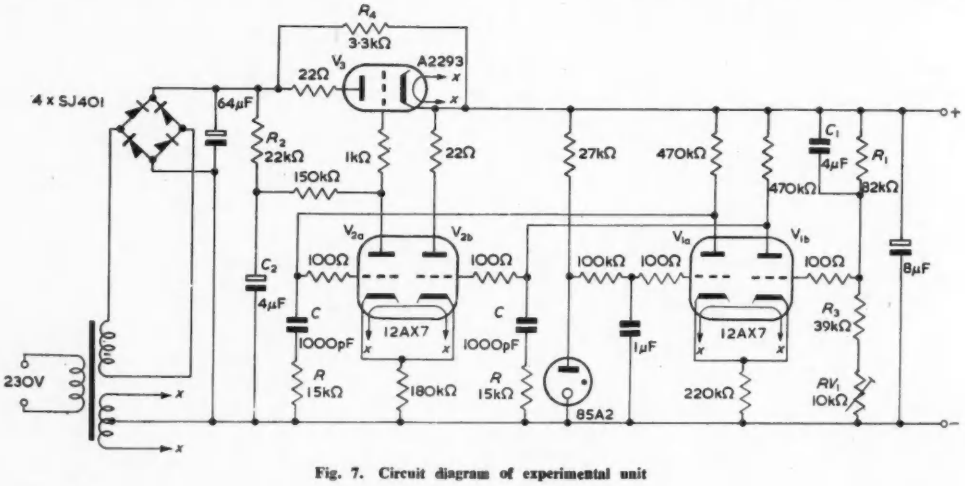


Fig. 7. Circuit diagram of experimental unit

The circuit of Fig. 5 serves to indicate some basic problems in the design of highly stable supplies.

It will be seen that the current feed for the reference tube is derived from the unstabilized supply, thus the reference voltage is susceptible to small variations due to changes in the unstabilized supply. This effect can be virtually eliminated by feeding the reference tube from the stabilized output.

A further disadvantage of the circuit of Fig. 5 is that the pentode current flows through the reference tube. Operational changes in this current will produce reference voltage changes by virtue of the dynamic resistance of the reference source. In addition, if the reference has a high dynamic resistance, the pentode gain is reduced.

Another problem is that of contact potential drift due to heater voltage variations. A measure of the problem is given by the fact that a 10 per cent variation in heater voltage can produce an equivalent grid-cathode signal of the order of 100mV. If one considers a supply of the

There are occasions when highly stable supplies are required and cannot be achieved by the above techniques. The designer must then resort to the use of chopper drift correction in the d.c. amplifier. This system is in common use in the instrumentation and analogue computing fields. When this system is used, a better reference is often also required.

There is available on the market a power supply[2] intended for analogue computing work, using a standard cell reference source and incorporating a drift corrected amplifier. This supply has an output voltage accuracy of 0·1 per cent, a long term stability of 0·1 per cent, and a stabilization factor of 4 000 : 1.

Design Considerations

Each design must be considered on its merits, and the resultant circuits should be no more complex than the

specification requires. A power supply must have exceptional reliability, and thus must be of the simplest possible design. In order to illustrate one approach to a design problem, the Appendix contains design details of a simple fixed current load power supply.

General

By use of simple circuit configurations, some measure of improvement and/or simplification can be carried out. Typical examples shown in Fig. 7 are

(a) It is possible to increase the loop gain for hum and higher frequencies, by shunting the input arm of the feedback network with a capacitor. C_1 is used for this purpose.

(b) The R_2C_2 decoupling system reduces the breakthrough of the basic ripple into the amplifier loop.

(c) R_1, R_3 and RV_1 should be high stability type components. In high stability supplies, wirewound types are preferred.

(d) In systems which are not required to operate with zero load, the series valve complement can be reduced by the use of a 'bleed-by' resistor R_4. Its use in Fig. 7 is comparatively light. Care must be taken when using 'bleed-by', to ensure that the series valve is not cut off under conditions of high supply voltage and minimum load.

Loop Stability

A common problem to all closed loop stabilizers having high loop gain and more than two effective time-constants is that of loop stability.

Loop stability, in this sense, implies freedom from parasitic oscillations under all conditions of operation. By Nyquist theory, it can be shown that oscillation will inevitably occur at some frequency, unless precautions are taken to reduce loop gain without introducing excessive phase shift. If the loop gain can be reduced to unity and during the process adequate phase margin is maintained, the loop will be stable. The phase margin is a measure of the stability of the loop.

Safe reduction of loop gain can be effected by inserting a suitable combination of phase-shaping networks of the type shown in Fig. 8. This network has the property of introducing a known maximum attenuation and a phase characteristic which starts from zero, rises to a maximum, and finally reduces again to zero. By virtue of this, considerable attenuation can be introduced without the embarrassment of excessive phase shift. These techniques have been widely used to stabilize a variety of closed loop circuits, but every design must be treated as a separate problem with its own complexity.

A desirable property of a stabilized power unit is that it can be subjected to any degree of capacitive loading. Such capacitive loading can result from wiring capacitances and certain load configurations. In order to ensure absolute loop stability under these conditions, it is desirable to arrange the phase-shaping networks to cater for a purely capacitive load. In addition, in the interests of low source impedance over a large frequency range, a large capacitor should be built into the supply and connected across the output terminals.

Without this capacitor, the source impedance of the supply would increase as the loop gain decreased. With the capacitor, the impedance rises to a maximum at mid-band frequencies and falls away at the high frequency end of the spectrum.

The output capacitor makes the output time-constant large, and it becomes the major time-constant in the loop and limits the maximum phase margin to 90°, thus making the stabilization problem even more difficult.

Conclusion

Some aspects of power supply design have been discussed, but economy in design is being constantly improved by the introduction of new and more efficient components.

The circuit designer requiring power supplies is advised to tailor his circuits to work from standard packaged commercial units, wherever possible. If a special design is necessary, this article may indicate a method of approach.

Acknowledgments

The authors wish to record their thanks to the Directors of Solartron Research & Development Ltd for permission to publish this article.

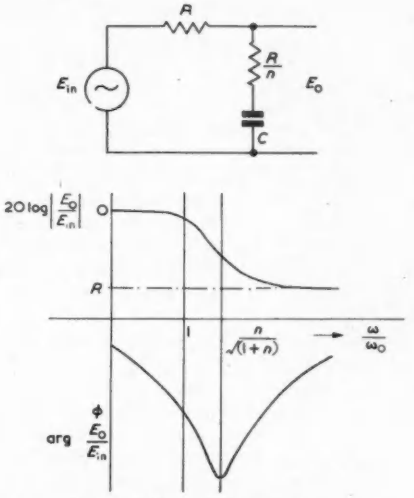


Fig. 8. Phase shaping network

Maximum ϕ *occurs at* $\omega/\omega_0 = \frac{n}{\sqrt{(1+n)}}$

Maximum attenuation $R = 20\log 1/1+n$

Appendix

The design of a simple supply having the following specification is dealt with:

Output voltage	250V ±5V
Output current	50mA
Source impedance	Less than 1Ω, d.c. to 100kc/s
Noise and ripple	Less than 1mV peak-to-peak
Stabilization ratio	Greater than 400:1
Input voltage	Normal 230V, 50c/s ±5 per cent voltage variation

A circuit complying with this specification is shown in Fig. 7. The first step was to choose a suitable series element, and the choice fell on the G.E.C. A2293. For a 50mA current, a valve anode-cathode voltage of 30V is required at −1V bias. Thus the minimum reservoir voltage is 255 + 30 = 285V.

The current required for the d.c. amplifier and reference tube is supplied by a bleed resistor. This resistor allows 9mA to flow at minimum reservoir voltage.

The nominal reservoir voltage is 285V + 8 per cent. This makes allowance for transformer errors, giving a value of 308V, but a further allowance must be made for reservoir ripple. Using a 64μF reservoir capacitor and full wave rectification, the ripple was estimated at 10V peak-to-peak. The

nominal d.c. level at the reservoir is thus 308 + 5 ≃ 315V.

For economy, silicon junction rectifiers were used. Their high forward efficiency requires lower transformer voltage, thus enabling the designer to use electrolytic capacitors which can have high values for small physical size. A large reservoir capacitor eliminates the need for a choke, and thus the regulation is further improved. In order to utilize rectifiers of low p.i.v. rating, a bridge rectifier circuit was used.

Due to the use of a large reservoir capacitor, the peak charging currents are high, and this results in some clipping of the secondary waveform. The nominal 315V d.c. required would give an ideal secondary voltage of 230V r.m.s., but in practice a voltage of 240V r.m.s. is required. The peak a.c. voltage which is encountered at the highest secondary voltage condition is 340V.

On consideration of source impedance and ripple, a loop gain, βM, of at least 60dB was required in the amplifier.

A convenient reference tube is the Mullard 85A2 which gives a feedback network transmission, β, of approximately one-third at d.c. This implied an amplifier gain, M, of >70dB. Use of two 12AX7 cascaded amplifiers, under the conditions shown, produces the required gain.

Care has been taken during the design to cater for the voltage variations which occur due to loop operation and due to component tolerances. A point that must be noted is that the bleed current under the worst conditions can be approximately 30mA, the valve current thus being reduced to 30mA. This requires a grid swing of approximately 19V.

The stabilization ratio required is met easily by a cathode-coupled amplifier.

In order to produce low source impedance at high frequencies, the output terminals are shunted with a large value capacitor. This is essential, due to the difficulties of maintaining the high loop gain at the higher frequencies, but its introduction makes the output time-constant large. This large time-constant is the major time-constant in the loop. For the present design, this time-constant has a 3dB frequency of about 200c/s, and has introduced a phase shift of greater than 86° at frequencies above 2kc/s. The resultant attenuation at 2kc/s is 20dB, and is increasing at the rate of 20dB per decade.

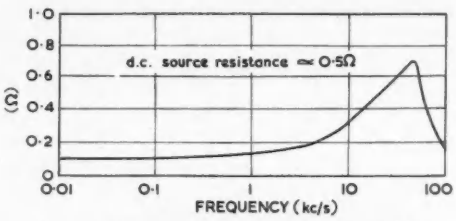


Fig. 9. Source impedance of experimental unit 5Ω

There are two other significant time-constants in the loop, those associated with V_{1a} anode and V_{2a} anode. The time-constant at V_{1a} anode was estimated to have a 3dB frequency limit of about 10kc/s, and that at V_{2a} anode a limit of 55kc/s. Due to these additional time-constants. there would be instability between these frequency limits. In order to prevent this instability, it is necessary to reduce the loop gain at the critical part of the spectrum. This is achieved by use of a phase shaping network, and it is convenient to modify the anode time-constants of V_1 by means of the networks, RC. Using the values shown, V_{1a} time-constant has a new 3dB frequency of 1kc/s, and at 55kc/s has introduced an attenuation of approximately 21dB with a phase shift of about 10°. The network introduces a maximum phase shift of about 57° at 3kc/s, but this is of no consequence, since the total phase shift in the loop at this frequency is then only 148°.

The loop gain has reduced to unity by about 60kc/s, and up to this frequency the phase margin has always been greater than 30°.

The measured performance figures on an experimental unit were:

Output voltage range	240 to 260V at 50mA
Source impedance	as plotted on Fig. 9
Noise and ripple	0·8mV peak-to-peak at 50mA
Stabilization Ratio for ±5 per cent	800 : 1

REFERENCES

1. SHEA, R. F. Transistor Circuit Engineering.
2. Solartron Precision Analogue Computer Equipment Publications. (Solartron Electronic Group).

A High Stability Electrostatic Generator

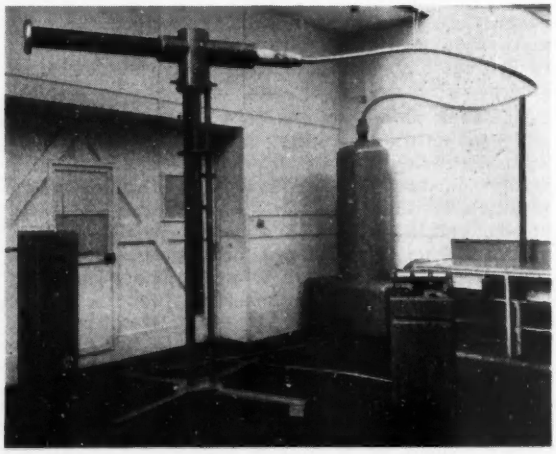
A high stability electrostatic generator was recently demonstrated by Miles Hivolt at their Shoreham Airport works.

This machine which will deliver an output of 600kV at 4mA is made by the Societe Anonyme de Machines Electrostatiques (SAMES) of Grenoble and consists essentially of a vertical cylinder pressurized to 15-25 atmospheres and containing a rotor of insulating material driven at 3 000rev/min by a motor at the base of the cylinder.

Excitation of the rotor is provided by an r.f. oscillator and rectifier equipment and the output voltage, which is adjustable to any value up to 600kV, can be stabilized to 0·1 per cent.

A separate control unit contains protective circuits against voltage and current overloads and an additional feature is a circuit designed to lower the output voltage when sparking occurs and to raise it slowly again to its former value when sparking has ceased.

Because of its small size and low weight it is readily transportable and is thus suited for field tests of transmission lines. The generator may also be used on a high voltage accelerator.



The SAMES 600kV generator with its associated control unit and power cabinet.

Telemetering Employing the Principle of the Gas-filled Stepping Tube

By Yoshisuke Hatta*

A method of telemetering of mechanical displacement employing the principle of the gas-filled stepping tube is described. As it is an electronic device it has good high speed operation, and is, therefore, superior in some respects to electromagnetic systems which have considerable inertia.

(Voir page 248 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 254)

TELEMETERING of mechanical displacement is usually achieved by using the self-synchronous motor but, because of its inertia it is incapable of the quick response which modern telemetering demands. This article presents a new method of telemetering using the principle of the gas-filled stepping tube. As this is an electronic device its speed of response is excellent and, moreover, it is convenient for practical applications because the whole device is very simple.

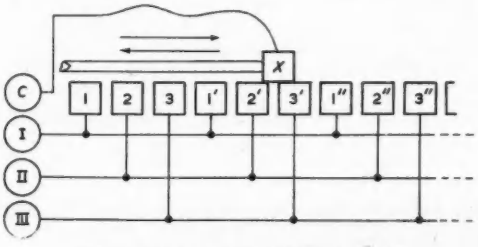


Fig. 1. Transmitter of 3 channel method

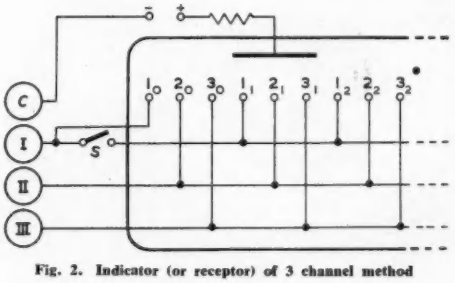


Fig. 2. Indicator (or receptor) of 3 channel method

Three Channel Method

The principle of this method is shown in Figs. 1 and 2. Fig. 1 represents the elementary structure of the transmitter which converts the mechanical displacement to the electric signal. It has contacts, 1, 2, 3, 1′, 2′, 3′, ..., and a sliding contact (X) which follows the displacement to be measured. Fig. 2 represents the indicator (or receptor) which consists of a gas-filled stepping tube. It has a common anode (A) and rod like cathodes in three groups, (1_0, 2_0, 3_0, ...) (1_1, 2_1, 3_1, ...) (1_2, 2_2, 3_2, ...). Each group is called 1, 2 and 3 successively. The transmitter and the receptor are connected by 4 lines (I), (II), (III) and C which form three channels between them. In normal operation the switch (S) is closed. Now, take a case in which X is on the contact 2′, and the glow of the stepping tube is at 2_1. Then, as X moves from 2′ to 3′, the glow transfers from 2_1 to 3_1 which is closest to 2_1 among the cathodes of 3 group, according to the principle of the gas-filled stepping tube. If X moves reversely from 2′ to 1′, the glow transfers from 2_1 to 1_1 for the same reason. Thus, one to one correspondence between the transmitter and the receptor is secured independently of the number of contacts, and the glow follows the movement of X. S is used for resetting. If it is required to reset the glow to 1_0, X is put on 1 and S is opened when the glow will jump to 1_0 from any position of 1 group. After resetting, S is closed and the whole set enters into normal working.

The stepping tube shown in Fig. 2 is the same as the double pulse Dekatron in structure, but differs from it in mode of operation; i.e. while the cathodes of 1 group operate as index cathodes and the cathodes of 2 and 3 groups are used as guides in the Dekatron, all cathodes act as index cathodes in the stepping tube.

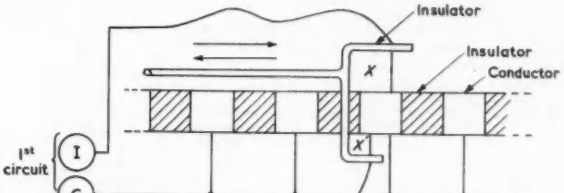


Fig. 3. Transmitter of 2 channel method

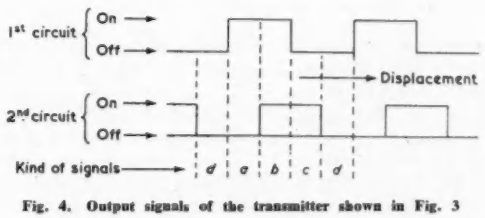


Fig. 4. Output signals of the transmitter shown in Fig. 3

Two Channel Method

Figs. 3 and 4 show the elementary structure and the waveforms of the output signals of the transmitter for the two channel method. These were originally used by Kondo and Takahashi in the so-called K.T. wheel[1]. It will be seen that the waveforms of Fig. 4 are similar to those of the input voltages of the double pulse Dekatron. So, when those output signals are applied to a double pulse Dekatron of conventional type, with appropriate circuit constants, the glowing position will move following the movement of X. But the double pulse Dekatron is inadequate as an indicator tube because it has cathodes of three groups while the transmitter shown in Fig. 3 generates four kinds of

* Tohoku University, Japan.

signals per cycle and, consequently there is a rather complex relationship between the displacement of X and the glowing position.

Due to these considerations, the author makes use of a stepping tube which has cathodes in 4 groups (the single pulse Dekatron has an electrode structure of this type).

The operation of the circuit shown in Fig. 5 can be explained as follows. Three terminals marked (I), (II) and C are connected to the corresponding terminals in Fig. 3 by 3 lines forming 2 channels between the transmitter and the receptor. First, consider the operation of V_1 (double triode). When the first circuit is open, V_{1a} is cut off by the potential drop across R_2, while V_{1b} is conducting because its grid is positively biased by R_3 and R_g. But when the first circuit is closed, E_b over-compensates the negative bias on V_{1a} given by R_2 and it becomes conducting, while

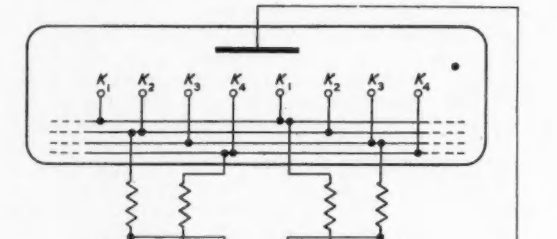


Fig. 5. Receptor circuit of 2 channel method

V_{1b} is cut off because the potential of its grid falls in accordance with the anode potential of V_{1a}. The operation of V_2 is similar to that of V_1. Owing to the operation of V_1 and V_2, two adjacent cathodes (K_1, K_2) will glow corresponding to the signal a of Fig. 4 and in the same way (K_2, K_3), (K_3, K_4) and (K_4, K_1) will glow corresponding to the signals b, c and d of the same figure, successively. So in the indicator tube, two adjacent cathodes are always glowing simultaneously and the position of glow follows the displacement X of Fig. 3 with linear proportionality. This mode of operation is quite different from that of conventional types of Dekatrons.

Some Developments

For measuring rotational displacement, the transmitters for linear displacement must be modified as shown in Figs. 6 and 7. In rotational displacement, the number of rotations may increase indefinitely. When this is the case, the receptor must have a decimal counting circuit which is capable of indicating the number of rotations. This decimal counting circuit which consists of a number of Dekatrons must have reversible coupling circuits[2] between two successive orders instead of the uni-directional ones used in conventional counting circuits.

As an example of the application of the three channel method, the author applied this principle to the indication of the reading of a dial-gauge. The transmitter which had

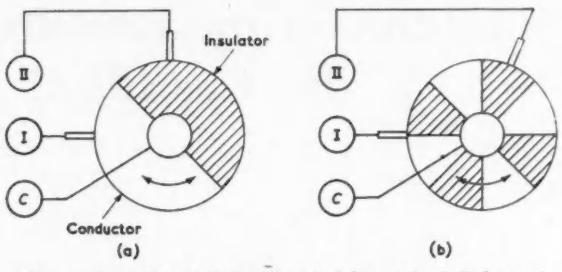
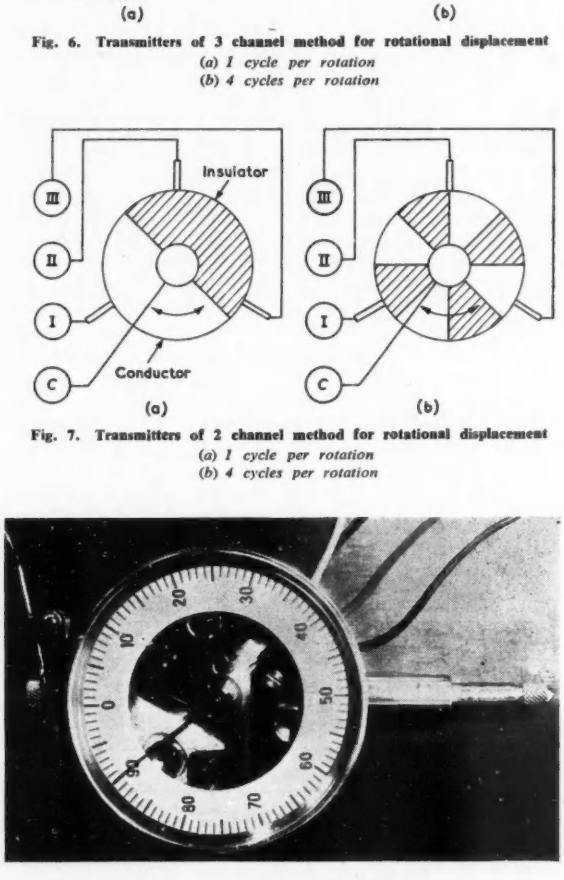


Fig. 6. Transmitters of 3 channel method for rotational displacement
(a) 1 cycle per rotation
(b) 4 cycles per rotation

Fig. 7. Transmitters of 2 channel method for rotational displacement
(a) 1 cycle per rotation
(b) 4 cycles per rotation



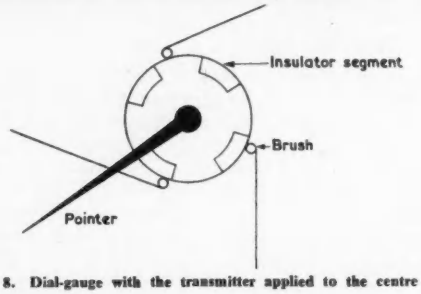


Fig. 8. Dial-gauge with the transmitter applied to the centre axis

the structure shown in Fig. 6 was applied to the main axis of a dial-gauge (Fig. 8). As an indicator tube, the author designed a linear form stepping tube which had 121 cathodes and could cover 10 rotations of the pointer of the dial-gauge.

The operation of the whole equipment was almost satis-

factory. But, when the speed of rotation was high, the output signals of the transmitter were sometimes erratic which was due to jumping of brushes and seemed to be inevitable so long as mechanical contacts were used. After replacing the mechanical switching element by photo-electric ones employing a light beam, a photo-transistor and a rotating shutter, the reliability of operation was improved.

Conclusions

The merits of this method of telemetering compared with others having similar functions are:

(1) The indicator is capable of giving sufficiently quick response for the measurement of mechanical displacement, and there is no slip between the displacement to be measured and the indication of the receptor.

(2) As it is a digital device, its operation is insensitive to drifts of circuit constants and fluctuations of supply voltage.

(3) A small and frictionless transmitter can be designed so as to give no disturbance to the movement of displacement to be measured.

Acknowledgments

The author wishes to express his thanks to Prof. Y. Watanabe who directed the work, to Prof. M. Kondo for his collaboration and to Prof. H. Takahashi for his valuable suggestions. This work was supported by a grant in aid for Miscellaneous Scientific Research of Japanese Government.

REFERENCES

1. KONDO and TAKAHASHI. *Kitainokenkyu 4*, 409 (1952). (In Japanese.)
2. BRANSON, L. C. Reversible Dekatron Counters. *Electronic Engng. 27*, 266 (1955).

A Three Digit Voltmeter

Ferranti Ltd have announced the introduction of their three-digit voltmeter D101 which incorporates full automatic ranging and polarity selection, the three ranges being as follows:

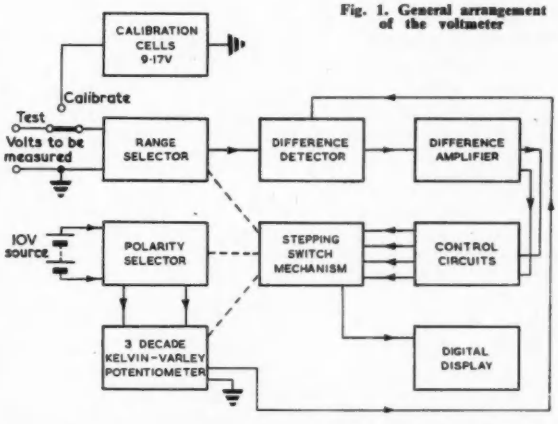
0·01 to 9·99V d.c. 10·0 to 99·9V d.c. 100 to 999V d.c.

The appropriate range is automatically selected to give the most significant reading so that, for example, 9·76V cannot be displayed as 09·8V or 009V. The resolution and linearity of the instrument is 0·1 per cent of the full scale reading on any range.

The measured voltage is read directly in digital form on a 1¼in by 5¼in projection display until giving 1in high numerals. The polarity and decimal point are also displayed, the decimal point placement being determined by the range selected. While the voltmeter reads only d.c., an a.c. to d.c. convertor is under development. The unique logic employed in the switching circuits considerably reduces the reading time which is 700msec on average, including ranging. The instrument has been designed for use on either 50c/s or 60c/s mains, and transistorized circuits give freedom from drift due to mains variations. High grade choppers have been incorporated to give complete stability and printed circuits have been used whenever possible to achieve the utmost reliability. To ensure the absolute accuracy of the instrument, a bank of nine Weston standard cells is built in for calibration. A suitable printer is under development for coupling directly to the voltmeter, all relevant information being presented at a socket at the rear of the unit, and it will be capable of recording two or three readings per second. A remote display may also be fitted instead of or in addition to the internal readout. The instrument is contained in a bench type cabinet measuring 17in by 13in by 10½in high, the weight being 50lb approximately.

The digital voltmeter

Fig. 1. General arrangement of the voltmeter



The principles of operation may be considered by referring to Fig. 1. The applied d.c. voltage is compared with the output from an internal decade Kelvin Varley potentiometer fed from a 10V d.c. reference source. Any difference between the two voltages is detected and causes the stepping switches to operate to select the correct range and polarity, and then to step the decades of the potentiometer to a 'balance', the latter being achieved when the difference between the two voltages is less than 6mV. The mercury cell reference source is calibrated against the bank of standard cells giving 1V, 100mV and 10mV steps respectively on the three decades of the Kelvin Varley network, and the average cell life is 1 000 hours. A 'stand-by' position is incorporated on the mains on-off switch, which allows the cells to be disconnected when the instrument is not actually reading. These cells are positioned to afford ease of access, being located at the rear of the unit, and an alternative reference source may be fed in if the instrument is to be used as a ratiometer. The Weston standard cell bank is also easily removable to enable it to be used elsewhere; alternatively, an external calibration source may be connected.

The limitations of moving pointer voltmeters are overcome by digital instruments, which are inherently more accurate, and also eliminate the fatigue associated with continuous reading. Moreover, it is possible to use less highly skilled labour in this task, thus releasing technical personnel for more important duties. Applications for the three digit voltmeter exist in the fields of automatic testing and monitoring, and wherever information can be presented in the form of a voltage. Examples of its use in production control are voltage measurement of batteries and for measuring thickness of materials by using voltages as parameters.

Solid Electrolyte Tantalum Capacitors

By Prof. Robert Aries*

Solid electrolyte tantalum capacitors have found ready acceptance for use in miniaturized equipment. In this article a brief description of the manufacturing process is given together with the results of life tests and temperature characteristics.

(Voir page 248 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 254)

WHILE semiconductors are well suited for miniaturized equipment, the associated components must also be miniature and have properties to match the high performances of the new transistors and rectifiers. An advance in this direction has been the successful manufacture on a large scale of miniature tantalum capacitors with a solid electrolyte.

While a non-liquid electrolyte capacitor was proposed more than 30 years ago, and has been known on a laboratory scale for two decades, the more recent emergence of better techniques, coupled with a strong demand for its performance characteristics has made the solid tantalum capacitor an industrial reality.

The use of solid electrolyte capacitors has been increased rapidly because of their obvious advantages. Electrolyte evaporation ceases to be a problem, the temperature range drops to −80°C, true hermetic sealing is feasible, and shelf life is indefinite.

While a number of solid electrolytes or semiconductors are known and can theoretically form suitable semiconductors between the dielectric and the cathode, and thus may be considered part of the cathode, there is the real difficulty that it is no easy matter to provide the proper related physical distribution in space between the dielectric and the semiconductor ' solid electrolyte '. One solution to this problem is given by Van Geel in which manganese dioxide is indicated as a semiconductor. In one varient a concentrated manganous nitrate solution is imbibed into the pores of an anodized sintered tantalum powder pellet or slug, and then the manganous nitrate is decomposed at elevated temperatures to form manganese dioxide. This is a violent reaction, liberating extensive volumes of reactive nitrogen oxide gases, and a great deal of art and experience is required to achieve successful results. Damage occurring fortuitously to the dielectric film must later be healed, and a series of anodizings to form and to heal the dielectric and to coat it can be carried out, which makes the entire operation both an art and a technology. When these operations are skilfully carried out the resulting unit, which is ultimately hermetically encapsulated, provides a unit small in size, high in capacitance, stable, trouble-free in operation, and with a practically unlimited life.

Although the recommended maximum operating temperature is 85°C, investigations indicate that use at temperatures up to 125°C is satisfactory, and particularly so if the voltages used are a little lower than the rated voltages. The voltage ratings available in solid electrolyte capacitors are 6V to 60V, but work is in hand to extend the upper limit.

Investigations with units from the 6V to the 60V range have shown that the capacitance is almost linear with temperature and that the capacitance increases with rising temperature. Thus, at 85°C the capacitance is 105 per cent of the capacitance at 20°C, so that the percentage coefficient of rise of capacitance per degree is 5/65 or 0·077 per cent/°C for the 60V units. This is shown in Fig. 1. A capacitance of up to 400μF has already been achieved in these units.

With lower voltage higher capacitance capacitors, the percentage coefficients are somewhat lower, being about 0·06 per cent/°C for the 6V units. The outstanding characteristic is that capacitance within the operational range increases somewhat between room temperature and the currently permissible highest operating temperatures by an amount between 5 and 10 per cent. Such units, after life testing for 1 000 hours at 60°C, show no appreciable change from the original room-temperature characteristics when again tested at room temperature.

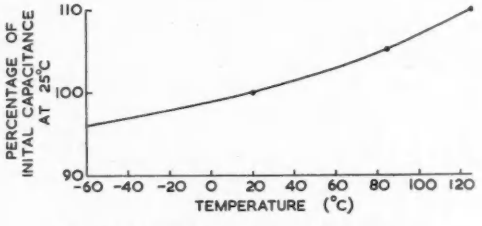


Fig. 1. Change of capacitance with temperature

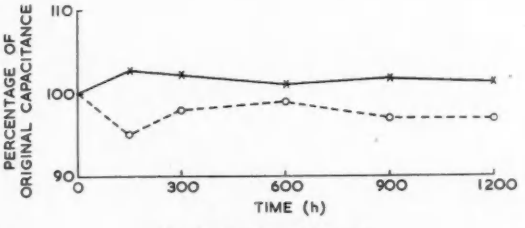


Fig. 2. Results of life tests

------ *per cent of original capacitance at 85°C measured after hours indicated at 85°C*

——— *per cent of original capacitance at 25°C measured after hours indicated at 85°C*

A large number of 60V capacitors (selected to give substantially equal initial capacitances to begin with) have been tested under various conditions, by removing random samples after life tests of 300, 600, 900 and 1 200 hours at 85°C. The capacitance was determined in each case on separate specimens at 85°C. The results are shown in Fig. 2.

This indicates that on life testing at the currently extreme temperature of 85°C for up to 1 200 hours there is a slight increase in the capacitance at 25°C (about 1 per cent) and a slight decrease in the capacitance at 85°C (not exceeding 4 per cent). Taking into account the rise in capacitance with increasing temperature (about 5 per cent at 85°C) the capacitance at 25°C and at 85°C after 1 200 hours of life testing at the rated voltage,

* *Consulting Engineer, Chimel, S.A. Geneva.*

remains slightly higher than the initial rated capacitance at 25°C.

Leakage current is, of course, an important characteristic of capacitors subject to specification and the leakage current rises rather sharply with temperature, but is almost independent of the voltage rating and the rated capacitance, and is possibly a characteristic of the geometry of the capacitor and the temperature for this type of capacitor.

A 60V unit of 0·6μF capacitance showed the following leakage losses at various temperatures:

Temperature (°C)	Leakage (μA)
0	0·11
20	0·15
25	0·23
40	0·41
50	0·57
60	0·80
75	1·20
85	1·75

This indicates that a rise in temperature of 20 to 25°C about doubles the leakage loss for the range of 0 to 85°C. This is shown in Fig. 3.

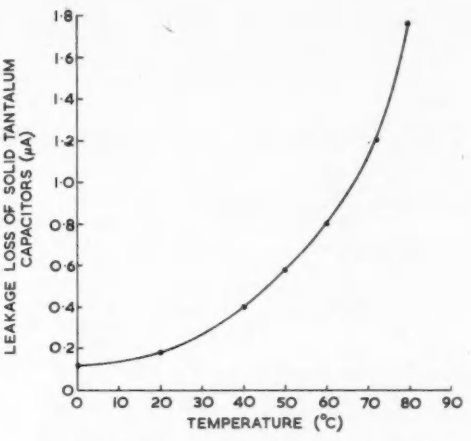


Fig. 3. Variation of leakage with temperature

Alongside many other new products in electronics, the production of tantalum capacitors is a new and interesting development. Continued improvements will be made in it, so that it is not unreasonable to expect increased capacitance, voltage ratings and temperature ranges.

While research under way may eventually change the metal to niobium or zirconium, the solid type may be considered as important a development as electrolytics were at their inception.

New High Power Transmitters at Ongar

Seven new transmitters have recently been brought into operation at the G.P.O. radio station at Ongar, Essex.

Designed to a Post Office specification, they were manufactured by Standard Telephones and Cables Ltd and they incorporate the latest developments in high-power, high-frequency transmitter design. To provide for maximum flexibility in use, the transmitter equipment is divided into two groups. The first group is arranged to receive the signals sent by line from the sending office, to convert them to a standard frequency (3·1Mc/s) and to deliver them to the second group—transmitter proper—at a standard power level (0·25W). The transmitters can each radiate a peak power of 30kW at any frequency between 4 and 27·5Mc/s and remote control facilities allow any transmitter to be run up on any one of six pre-selected frequencies, with ability to change from one frequency to another at will—the change takes less than a minute. Similarly, the transmitters can be closed down by remote control.

Facilities are provided for the monitoring of the signals leaving the transmitters, and a pick-up from the output of any transmitter can be fed back to a control room for inspection by a spectrum analyser and other monitoring apparatus to ensure correct operation.

Elaborate steps have been taken to ensure safety, both of the staff, and for protection of the equipment itself. All the oil-filled apparatus is enclosed in a fire-proof room, and the transmitter cubicles are fully interlocked with the main power supply switch, so that access to the interior of the equipment cannot be obtained until the power is disconnected. The power supply is taken from the public mains at 11kV and transformed down at each station to feed the equipment at medium voltage. Standby diesel alternators can replace the public supply in the event of a failure.

This latest addition to the capacity of the Ongar Radio Station will enable the Post Office to provide more and better international telegraph services to most parts of the world. These services include international telex, picture telegraphy and the leasing of circuits to customers for their individual use. There are three separate transmitter buildings on the station operating four long-wave and thirty-three short-wave transmitters. Two of the three buildings are normally unstaffed, and the transmitters in them are remotely operated from the third.

One interesting feature of the Station is the 300ft masts carrying the long-wave aerials that service Europe, and the short-wave Franklin aerials for the services to Bombay, Melbourne, New York and other overseas territories. The new transmitters use rhombic aerials, mounted in pairs one above the other on the same masts, and employing different frequencies, an aerial switch automatically connecting the correct aerial according to the wavelength in use at the time.

The first radio station was established on the site by the Marconi Wireless Telegraphy Company in 1930. Subsequently developed by Imperial and International Communications (later Cable and Wireless), the station was taken over by the Post Office in 1950.

In its early days the Station used long-waves for its services to the Continent, but by 1931 short-wave transmitters had been installed and the Station had become Britain's principal radio station in the beam telegraph services to the Commonwealth.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

Response of a Capacitance-Resistance Divider

DEAR SIR,—Mr. S. Turk's useful results in your October issue for three specific forms of input may be generalized for an arbitrary input which may be known only numerically or as an oscillogram. If the divider has zero initial stored energy and $V_s(t)$ is the response to a unit step function input, then by Duhamel's Theorem the response to any input $V_1(t)$ is given by

$$V_2(t) = V_s(o)\,V_1(t) + \int_0^t V_1(x)\,V_s'(t-x)\,dx \quad \ldots\ldots (1)$$

where V_s' denotes the first derivative. Substituting the known response

$$V_s(t) = k\,(1 - \alpha e^{-t/\nu})$$

where

$$k = \frac{R_2}{R_1 + R_2}\;;\quad \nu = \frac{R_1R_2\,(C_1 + C_2)}{R_1 + R_2}\;;$$

$$\alpha = 1 - a = 1 - \frac{(R_1+R_2)\,C_1}{R_2\,(C_1+C_2)}$$

one obtains

$$\frac{V_2(t)}{k} = (1-\alpha)\,V_1(t) + \alpha/\nu \int_0^t V_1(x)\,e^{-(t-x)/\nu}\,dx \quad \ldots\ldots (2)$$

It is convenient to introduce what may be termed the *distortion* of the divider, a function of time defined by

$$D(t) = V_1(t) - V_2(t)/k \quad \ldots\ldots (3)$$

This function indicates the extent to which the response to a particular form of input deviates from that of an ideal divider having a constant division ratio k, and it is of course zero for a pure d.c. input. Substituting equation (2) in equation (3) one obtains

$$D(t) = \alpha\left\{V_1(t) - 1/\nu\int_0^t V_1(x)\,e^{-(t-x)/\nu}\,dx\right\} \quad \ldots\ldots (4)$$

This expression may be evaluated numerically if $V_1(t)$ is only known numerically. It is immediately apparent that for all forms of input the distortion is zero if $C_1R_1 = C_2R_2$, since in this case $\alpha = 0$.

By successive integrations by parts, the following series form of the expression is obtained.

$$D(t)/\alpha = \nu V_1'(t) - \nu^2 V_1''(t) + \nu^3 V_1'''(t) \ldots\ldots + e^{-t/\nu}\left\{V_1(0) - \nu V_1'(0) + \nu^2 V_1''(0)\right\} \quad \ldots\ldots (5)$$

The main application of the series is for the case of a small value of the time-constant ν, or for a slowly varying input, where the region of interest is not too near the origin (say $t > 4\nu$). Then the second series, which represents the initial transient, is negligible and the first series converges rapidly. A graphical method

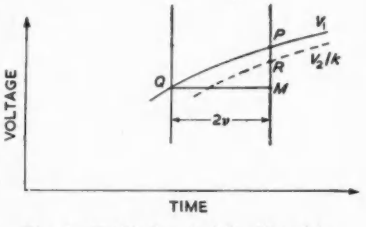


Fig. 1. Graphical method for determining distortion

for determining the distortion in this case is shown in Fig. 1, where P is the point on the curve of V_1 corresponding to time t. Draw a vertical through P and another a horizontal distance 2ν to the left, cutting the curve at Q. Draw a horizontal through Q cutting PM at M. Then it may be shown that $\alpha/2 \times PM$ is the distortion at time t. with an error of about one third of the third term of the series. Hence if $PR = \alpha/2 \times PM$, then R is a point on the response curve V_2/k, and by repeating the process a portion of the response curve may quickly be drawn.

A limitation of the series form (5) is that it is applicable only in an interval in which there are no discontinuities of V_1 or its derivatives other than at the origin. For example, it cannot be applied to the ramp function of Fig. 7 of the article. If there are discontinuities at the origin, each term is given the value it takes just *after* the discontinuity.

When the input is known as an algebraic function, an advantage of expressing the response in terms of the distortion is that it usually involves fewer independent variables, and hence may be represented by a smaller family of curves. For example, the distortion for a step function input is, in the notation of the article, given by

$$D/A_o\,(1-a) = e^{-t/\nu} \quad \ldots\ldots (6)$$

and for an exponential input

$$D/A_o\,(1-a) = \frac{\Gamma}{1-\Gamma}\left\{e^{-\Gamma t/\nu} - e^{-t/\nu}\right\} \quad \ldots\ldots (7)$$

These equations are simpler than equations (3) and (5) of the article. If preferred, the *fractional* distortion may be plotted, without increasing the number of variables. by dividing by the input function V_1. For all forms of input, the fractional distortion at $t = 0$ is $(1-a)$.

Yours faithfully,

R. H. EVANS

Farnborough,

Hants.

The Author Replies:

DEAR SIR,—Mr. Evans is treating the divided response in a more general way. However, his graphical method applies mainly to the later part of the response where the transients are disappearing or negligible, while I put emphasis on the initial part of the waveform. I therefore consider his results as a generalization in range, that was not of main interest in my article. This very point Mr. Evans made clear in his letter.

Yours faithfully,

S. TURK,

Institut 'Ruder Boskovic,'

Zagreb,

Yugoslavia.

A Cordless Telephone Switchboard

DEAR SIR,—In your January issue you published details of a Cordless Telephone Switchboard installed at the European headquarters of the Canadian Pacific Railway Company in London.

The first cordless board in this country was installed by Siemens Bros Ltd (now Siemens Edison Swan) for the Post Office at Thanet in 1955. Reference to this can be found in the *Post Office Engineering Journal*, Vol. 48, Part 2, July 1955. Other cordless exchanges have been under construction since this date, including one at the Royal Victoria Hospital, Belfast, which has been working for the past year.

Yours faithfully,

N. F. SAY

Streatham.

London, S.W.2.

'Droop' and Low Frequency Bandwidth

DEAR SIR,—While sufficiently accurate relationships between the rise-time of a pulse and the −3dB high frequency bandwidth of an amplifier are well known, it would appear that the relationship between the 'droop' of a pulse and the low frequency bandwidth is less well known.

For small droops, of the order of 15 per cent, such as are chiefly of interest in amplifier design, the relationship may be stated as:—

$$D = \omega\tau \quad \ldots\ldots (1)$$

where D = Droop

$$= \frac{e_o - e_{o_\tau}}{e_o}$$

e_o = output voltage at $t = 0$

e_{o_τ} = output voltage at $t = \tau$
$\omega = 2\pi f_1$
f_1 = −3dB low frequency band edge.
τ = pulse duration.
$\alpha = 1/CR$

This may be shown as follows:—

The droop, as defined, is given by

$$D = \frac{e_o - e_{o_\tau}}{e_o} = 1 - e^{-\alpha\tau} \quad \ldots\ldots\ldots\ldots (2)$$

The low frequency band edge is defined by

$$\omega = 1/CR \quad \ldots\ldots\ldots\ldots (3)$$

For small values D, less than 0·15, or 15 per cent sag,

$$D = \alpha\tau \quad \ldots\ldots\ldots\ldots (4)$$

Substituting equation (3) into equation (4). observing that $\alpha = \omega$.

$$D = \omega\tau \quad \ldots\ldots\ldots\ldots (1)$$

Whence $f_1 = \frac{D}{2\pi\tau}$ etc.

Accurately

$$f_1 = \frac{\ln 1/(1 - D)}{2\pi\tau} \quad \ldots\ldots\ldots\ldots (5)$$

It will be agreed that equation (1), a particularly easy expression to remember and use, is of more practical use than equation (5) or some other published equations invoking a knowledge of the amplifier phase response.

In the case of N non-interacting couplings it will be found that equation (1), for the purpose of quick estimation, gives a pessimistic answer.

Yours faithfully,

T. G. CLARK

Radar Development Laboratory,
Decca Radar Ltd.

Design Curves for Simple Filters

DEAR SIR,—With reference to the article by D. J. H. Maclean of Messrs. Barr and Stroud, in the November issue of ELECTRONIC ENGINEERING, I would be grateful if you would pass the following query on to the author.

In Example 3 in the above article there are two tables, one specifying a band-pass filter of 50kc/s bandwidth and the other a low-pass filter from which the first is derived.

I suggest that the second table should read:—

Attenuation	*Frequency Interval*	*Normalized Interval*
⩽0·5dB	$0 \leqslant f \leqslant 50$kc/s	$0 \leqslant \omega/\omega\beta \leqslant 1$
⩾ 50dB	$75 \leqslant f \leqslant \infty$	$1{\cdot}5 \leqslant \omega/\omega\beta \leqslant \infty$

This is consistent with the interval from the assumed zero to the upper 50dB point being 75kc/s. If, as the author states, it is the total interval between the 50dB points that must be considered, i.e. 100kc/s, why, in the table in Example 1, is the frequency interval given as 2kc/s and not 3kc/s, when 3kc/s is the total frequency interval between the 36dB points.

There seems to be an inconsistency between these two tables, both of which make use of the same assumptions in specifying low-pass filters.

Yours faithfully,

L. B. JONES

Bristol Aero-Engines Ltd,
Bristol.

The Author Replies:

DEAR SIR,—The apparent inconsistency between Example 1 and Example 3 which Mr. Jones has pointed out is, I suggest. based on a misunderstanding. Example 1 deals with a straightforward low-pass filter, consequently there is only one 36dB point on the attenuation characteristic, not two as Mr. Jones implies. In the case of Example 3, the low-pass/band-pass transformation is involved, an important property of which is that when going from a coil to a series resonant circuit (and from a capacitor to a parallel resonant circuit), the bandwidth in cycles at any given attenuation level remains the same, if the coil (and capacitor) is unchanged (see, for example, 'Network Analysis and Feedback Amplifier Design', pp. 211-214, by H. W. Bode). As one can see from the Example 3. this is exactly what is done, and therefore the given table for the low-pass prototype is correct.

Yours faithfully,

DOUGLAS J. H. MACLEAN,

Barr and Stroud Ltd,
Glasgow.

Characteristics of Transistors

DEAR SIR,—In the course of investigating the V_c-I_c characteristics, at high currents, of a number of types of junction transistor a second regression in the avalanche characteristic has been observed which appears to have received little, if any, attention in published literature.

Typical characteristics are shown in the accompanying figures reproduced from oscilloscope trace photographs; the scanning current was a single-shot ramp pulse of 200μsec duration. Traces shown in the first three figures are:

(1) V_{cb} characteristic with emitter open-circuited.
(2) V_{cb} or V_{ce} characteristic with base shorted to emitter.
(3) V_{ce} characteristic with base open-circuited.

Fig. 1(a), (b) and (c) are for samples of a medium power junction transistor, the form of the regression being clearly seen as a rapid voltage break-back occurring at 2·6A in trace (b) and at 1·7A in trace (c) (curves (2)). Two interesting features appear: firstly that the effect occurs most readily in the base-emitter short-circuit condition, secondly that the effect is incipient in the collector-base characteristic (1) of Fig. 1(c) at a current approximately the same as that at which breakdown occurs in the base emitter short-circuit conditions. Trace (1) in (c) was made before trace (2).

Tracing the reverse characteristics of a number of germanium junction diodes a somewhat similar breakdown appears, a trace for one sample being reproduced in Fig. 1(d). For both transistors and diodes scanning the characteristic results, in some instances, in the destruction of the device: in other instances the process of scanning the characteristic beyond the regression point may apparently be repeated indefinitely without deterioration of the device, the position on the characteristic at which the break-back occurs being apparently not related to the rated power dissipation of the device.

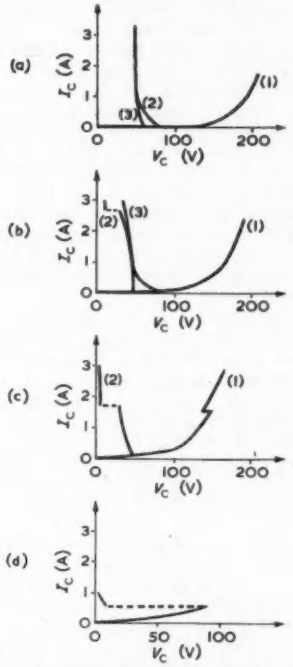


Fig. 1. Samples of a medium power junction transistor

As the form of the characteristic resembles that of semi-conductor devices[1,2] especially designed for two-state operation it may be speculated that the mechanism of the effect might be explained along similar lines. There is also the possibility that the effect is caused thermally if it is assumed that the collector current is constricted into narrow channels. In this connexion it has been noted that there exists a thermally stable negative-resistance[3] region of the reverse characteristic of a pn junction.

Yours faithfully,

B. J. HOLMES,

Electronics Research Laboratory,
The British Tabulating Machine Co. Ltd.

REFERENCES

1. MOLL, J. L., *et al.* PNPN Transistor Switches. *Proc. Inst. Radio Engrs. 44*, 1174 (1956).
2. MUNCH, VON W. A Transistor with Thyratron Characteristics and Related Devices. *J. Brit. Instn. Radio Engrs, 18*, 645 (1958).
3. MATZ, A. W. Thermal Turnover in PN Junctions. *Proc. Instn. Elect. Engrs. 104B*, 555 (1957).

BOOK REVIEWS

Radio Communication

By W. F. Lovering. 536 pp. 80 figs. Demy 8vo. Longmans Green & Co., New York, London. 1958. Price 60s.

THIS is a book for engineering students written from an engineer's viewpoint.

Although essential mathematics are included, sometimes in Appendices at the end of a chapter, it is pleasing to find explanations and descriptions in physical and practical terms rather than a complete reliance on mathematical formulae. This is well exemplified by the chapter on Transmission Lines and feeders, where a physical picture of the conditions on the line is clearly indicated. Experience shows that many students require just this kind of explanation to supplement the mathematical treatment.

After an intial chapter introducing or revising some fundamental principles, the next four chapters cover the basic circuits which are essential in Radio Communication.

Then follows a chapter on valves and one each on radio-frequency and audio-frequency amplification. Wideband amplification is touched on, but as the title of the book is Radio Communication it is reasonable not to expect extensive coverage of subjects which belong more to television and radar. The requirements of these latter are briefly mentioned in the chapter on radio transmission and reception.

Feedback, oscillators, detectors and modulation each have a chapter and are followed by two chapters on transmitting and receiving circuits in which some representative practical circuits are given. The remainder of the book comprises a chapter each on power supplies, transmission lines (touching on waveguides), radiation and aerials, propagation, cathode-ray tubes and on transistors. Any of these could be the subject for a whole book, but the student will find them all an excellent introduction and packed with information.

The book is completed by a set of questions, with answers, relating to each chapter, and a useful index.

In a book of this size the author has to compromise between scope and completeness of detail. With so wide a scope the space devoted to each subject must be severely limited, and in some places additional diagrams would have helped.

In many instances the author points out the basic similarities and relations between what at first might appear to be quite separate problems. For example, modulation, detection and frequency changing are shown to be closely related.

He has also indicated how a problem may be solved by more than one approach, in particular, in the chapter on oscillators the action of the circuit is considered in three different ways. The book will help the student to learn that there is often more than one way of tackling a problem, and that it is important to exercise judgment in this respect, and also that in engineering many apparently diverse problems are closely related.

R. A. HERBERT

Handbook of Automation, Computation and Control. Volume 1: Control Fundamentals

By E. M. Grabbe, S. Ramo, and D. E. Wooldridge. 990 pp. 200 figs. Royal 8vo. John Wiley & Sons, Inc., New York, Chapman & Hall Ltd, London. 1958. Price 136s.

ALTHOUGH what is meant is more or less understood, no precise definition has so far been given of automation, computation or control. Each of these fields, according to viewpoint, training or particular enthusiasm, represents an approach to the evolving philosophy of Systems Engineering; a concept which is equally ill-defined as yet. The editors have sensibly chosen a title which will be interpreted widely enough to engage the attention of the most diverse audience. This is important since one of the greatest virtues of this newly recognized philosophy is its profound unifying influence, embracing servomechanisms, process control, economics, and many other previously unrelated mechanistic and sociological phenomena. This unification will only be possible if its influence reaches all who can benefit from it.

Being a handbook each chapter is a self-contained article, expertly introducing its subject, and supported by an adequate if not universally agreed choice of references. However the opportunity has been missed to include an introductory chapter showing why the selected topics are contained between the covers of this one book. Neither the foreword nor the preface, in only reiterating trite generalities, rise to the occasion.

A further, though perhaps less important editorial fault arises from the title of this volume, namely Control Fundamentals. The first sixteen chapters would better have been separated into an extremely valuable mathematical source book in its own right, leaving the remaining ten chapters aptly under the present title.

The book opens with a chapter on the theory of Sets and Relations and sharply puts the reader into the frame of mind that this is not just a handbook for ready reference, but also a text worthy of careful and patient study in its own right. The next twelve chapters cover Algebraic Equations, Matrix Theory, Finite Difference Equations, Differential Equations, Integral Equations, Complex Variables, Operational Mathematics, Laplace Transforms, Conformal Mapping, Boolean Algebra, Probability and Statistics. Each one is a skilful distillate of its subject.

Chapter 14 concisely describes most of the relevant methods of Numerical Analysis required in modern computation, while chapter 15, the longest in the book, deals with Operational Research, and includes the well-known techniques of Linear Programming and the Theory of Games, among others. The communication of intelligence is provided for in chapters 16, 17 and 18, which discuss, respectively, Information Theory, Smoothing and Filtering, and Data Transmission. It is surprising, however, that no chapter on network theory, in its own right, has been thought a subject worthy of inclusion in a handbook of this sort.

Feedback control techniques form the second half of the book starting with chapter 19 on the Methodology of Feedback Control. This chapter is indeed useful in restating the I.R.E. standard terms and symbols, and a useful table of nineteen performance specifications is given. This particular author, however, even in his title shows a flair for inventing words and their uses, and produces *horrendous*—and who knows, perhaps it means just that. Chapters 20, 21, 22 and 23 are headed Fundamentals of System Analysis, Stability, Relation between Transient and Frequency Response and Feedback Compensation respectively. These chapters are largely of selected material from the best of the literature on linear feedback control theory. All the familiar charts, response curves, tables of transfer functions, tables of transforms, root loci, etc., are included, and taken together form a very fine introductory textbook and reference. Noise, Random Inputs and Extraneous Signals is the title of chapter 24 and is a useful introduction to correlation techniques, although the subject of optimizing for minimum mean square error, or other figures of merit, is perhaps wisely only touched upon. The two final chapters deal with Non-linear Systems, and Sampled-Data Systems and Periodic Controllers. The first includes the salient features of describing-function theory and phase-plane techniques, and a little on non-linear system compensation. The chapter is a modest but valuable introduction, and also contains some very useful data on non-linear effects. Chapter 26 closes Volume I with a concise description of sampling system theory, featuring the z-transform.

Final judgment cannot be passed on this Handbook in its entirety, but if Volumes II and III maintain the standard of conciseness, and yet comprehensiveness, of Volume I, the whole should be an essential on every control, automation, or computing, engineer's bookshelf. The editors should be complimented on producing a work of remarkable evenness in style and quality from the efforts of no less than twenty-nine authors. The talent of American editors to project American talent in excellent books is truly remarkable, and is, in itself, a subject worth serious study and reflection.

K. C. GARNER

Audio Measurements

By Norman H. Crowhurst. 223 pp. 70 figs. Demy 8vo. Gernsback Publications, New York. 1959. Price $2.90.

THE author covers these measurements authoritatively and completely. Measurement techniques are described and evaluated. Test equipment, basic measurements and amplifiers are treated in detail. Measurements of output transformers, pre-amplifiers, pick-ups and arms, turntables and changers, tape recorders and microphones are also described.

Selected Papers on Quantum Electrodynamics

Edited by J. Schwinger. 424 pp. Demy 8vo. Dover Publications Inc. 1958. Price $2.45.

IN this volume the history of quantum electrodynamics is unfolded through the original words of its creators. Papers are included by Bethe, Bloch, Dirac, Dyson, Fermi, Feynman, Heisenberg, Kusch, Lamb, Oppenheimer, and many others. There are a total of thirty-four papers, twenty-nine of which are in English, one in French, three in German, and one in Italian.

International Radio Tube Encyclopaedia

600 pp. Royal 8vo. 3rd Edition. Bernards (Publishers) Ltd. 1958. Price 63s.

SINCE 1954 research in the radio valve industry has gone on unceasingly throughout the world and some further 9 000 types of radio valves have been produced, so that this present edition contains data on more than 27 500 valve types.

The scope of this encyclopaedia includes receiving valves including diodes, triodes, tetrodes, pentodes, heptodes, hexodes, tuning indicators, regulators, thyratrons, rectifiers, sub-miniature valves, television cathode-ray tubes, industrial and military type transmitting triodes, tetrodes, pentodes, cathode-ray tubes, klystrons, magnetrons, etc.

A new feature of this edition are the completely cross indexed equivalents tables, covering every receiving vale produced throughout the world with equivalents. These tables will enable users of the encyclopaedia to substitute alternatives when required.

An Introduction to Fourier Methods and the Laplace Transformation

By Philip Franklin. 289 pp. Demy 8vo. 2nd Edition. Dover Publications Inc., New York. 1958. Price $1.75.

THE author of this book is Professor of Mathematics at the Massachusetts Institute of Technology. It is an introduction to Fourier series and Laplace transforms. Applications to physical problems involving ordinary and partial differential equations are included. The reader is assumed to have a working knowledge of elementary calculus, but where topics of advanced calculus are needed, they are developed from the beginning.

There are thirty-one sets of practice problems, one for each major topic of the book. Answers to all problems are given at the end of the book.

Voice Across the Sea

By Arthur C. Clarke. 213 pp. Demy 8vo. Frederick Muller Ltd, London. 1958. 18s.

THIS book—the story of the submarine cable from its earliest days just over a century ago to the triumphant achievement of a transatlantic telephone cable in 1956 is one of the most delightful essays on a technical subject which it has ever been the reviewer's privilege to read.

Few scientists can write good English without being pompous or dull; perhaps an even smaller proportion of journalists can write accurately and with proper balance on scientific matters. Mr. Clarke has achieved both, for not only has he a deep appreciation of the romance in technical endeavour but he has the rare gift for being able to tell a technical story in a manner which is accurate, entertaining and fascinatingly instructive

This is not a history of submarine communications. The author's object, as he says, has been 'to entertain as much as to instruct' and, in doing so, the author wandered down some odd by-ways whenever the scenery has intrigued him. It will contribute little to one's understanding of telegraphy to know how Oliver Heaviside made tea, why Lord Kelvin's monocle revolutionized electrical measurements, what a Kentucky colonel was doing in Whitehall, how Western Union lost $3,000,000 in Alaska and what unlikely articles the Victorians made of gutta-percha. Yet it is precisely such trivia that make history three-dimensional and the author makes no apology for including them.

In little more than 200 pages, this is a brilliantly told story of the tragedies, romances and achievements associated with a century of submarine cables, of the personalities and the incidents which have contributed to both the triumphs and the disasters. It is the most absorbing book the reviewer has read for a very long time and it should certainly be read by everyone connected, however remotely, with electrical communication.

G. R. GARRATT

Optical Properties of Semiconductors

By T. S. Moss. 275 pp. 60 figs. Demy 8vo. Academic Press, New York. Butterworths Scientific Publications, London. 1959. Price 50s.

THIS book is primarily of interest to research physicists of academic or industrial laboratories, but will also be suitable for study by honours students concerned with solid state physics.

The opening chapters develop the theory of the optical properties of solids, including absorption by valence band electrons, free carriers and impurities, dispersion and magneto-optical effects. The book stresses the interrelation of the optical constants for any material, i.e. between the real and imaginary parts of the dielectric constants, the amplitude and phase of reflectivity and the refractive index and absorption constants. Reviews of the properties of the most interesting semiconductors are given and over 600 references are provided.

EE 8272 *for further details*

CHAPMAN & HALL

★ JUST PUBLISHED ★

Second Edition of

FUNDAMENTALS OF TRANSISTORS

by

L. M. Krugman

176 pages *Illustrated* *25s: net*

★

TWO JOHN WILEY BOOKS

Topics in ELECTROMAGNETIC THEORY

by

D. A. Watkins

127 pages Illustrated 52s net

ELECTROMECHANICAL ENERGY CONVERSION

by

D. C. White & H. H. Woodson

660 pages Illustrated 100s net

37 ESSEX STREET, LONDON, W.C.2

The Fundamental Principles of Quantum Mechanics with Elementary Applications

By E. C. Kemble. 611 pp. Demy 8vo. 2nd Edition. Dover Publications Inc., New York. 1958. Price $2.95.

THIS book is written by the Professor of Physics at Harvard University. It is an inductive presentation of quantum mechanics designed for the graduate student or the specialist in some other branch of physics. While some knowledge of advanced mathematics and the data of the physical sciences is desirable, treatment is simple, clear, and easily followed. Applications of the theory have been interwoven with the development of the basic mathematical structure.

Vector Analysis with an Introduction to Tensor Analysis

By A. P. Wills. 285 pp. 44 figs. Demy 8vo. 2nd Edition. Dover Publications Inc. 1958. Price $1.75.

ASSUMING no prior training in vector or tensor methods, and only a good working knowledge of calculus, the author develops the elements of vector algebra and calculus, the theory of scalar and vector fields and potential functions, transformations of volume and surface integrals, linear vector functions, coordinate systems, transformation theory, non-euclidean manifolds, and tensor theory. Numerous problems illustrate and extend each concept and enable the student to develop facility in handling vector and tensor notation.

THE ELECTRONIC COMPONENT EXHIBITION

A description, compiled from information supplied by the manufacturers, of selected exhibits to be shown at the Exhibition of the Radio and Electronic Component Manufacturers' Federation in Grosvenor House and Park Lane House, London, from 6 to 9 April. (*Figures in parentheses refer to stand numbers*)

(Voir page 243 pour la traduction française: Deutsche Ubersetzung auf Seite 249)

AVO LTD (73)

Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1.

COIL WINDING MACHINE

A new coil winding machine is being exhibited which is capable of winding almost perfect layer wound coils without the use of any medium of interleaving. The normal mechanical coupling between the headstock and the traverse of the machine has been dispensed with and both are driven by independent motors, whose relative speeds are electronically controlled by a sensing head which monitors the wire-feed angle so as to ensure that as far as practicable each turn is laid precisely beside the preceding turn. The greatly improved space factor of coils produced by this machine ensures maximum electromagnetic efficiency—a factor of particular importance for such components as relays and solenoids, especially the miniature types, while the far more precise rectilinear configuration of coils thus wound, opens up many possibilities of the use of self-supporting coils where formers were previously necessary.

EE 8751 *for further details*

BRAYHEAD (ASCOT) LTD (167, 169)

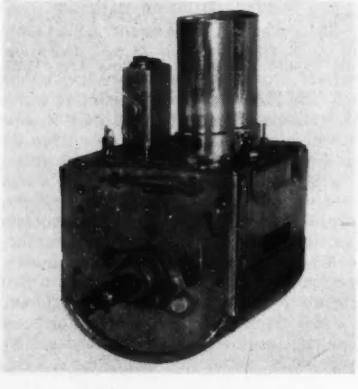
Full View Works, Kennel Ride, Ascot, Berks.

TELEVISION TURRET TUNERS

(*Illustrated below*)

The PB.1 tuner provides a high performance 10-position tuner, which is compact in construction with facilities for single and multi-channel loading, switched fine tuner range and provision for single or three-position f.m. sound. It offers a high standard of performance in respect of gain, drift, noise, stability and response shape.

The PB.3 and PB.4 tuners are the result of the combined efforts of Plessey and Brayhead. They have the same compact overall dimensions as the PB.1, providing 14 channels in the PB.3 and 18 channels in the PB.4, both retaining an additional position for the addition of a u.h.f. adaptor.



Television-f.m. switching can be provided either by a wafer switch mounted on the rear spindle extension or by a cam-operated slide switch, the latter being available in versions to suit single or multi-channel f.m. tuning.

The user has the option of many additional features giving flexibility of application; among these are:—

Printed i.f. filter, single or multi-channel f.m. tuning, built-in isolation components, narrow or wide-band fine tuner, adjustable aerial coils, inductive-coupled input circuit, double-tuned i.f. output circuit, single or dual channel loading, dual-frequency i.f. output circuit, built-in sensitivity switching, built-in aerial switching.

Provision is also made for the use of the PCC.89 valve, or the 30L15/30C15 combination.

In addition to normal U.K. channelling these tuners can be provided with channels for F.C.C. or C.C.I.R. systems, or for other special channels obtaining in overseas countries.

EE 8752 *for further details*

BRITISH PHYSICAL LABORATORIES (88)

Houseboat Works, Radlett, Hertfordshire.

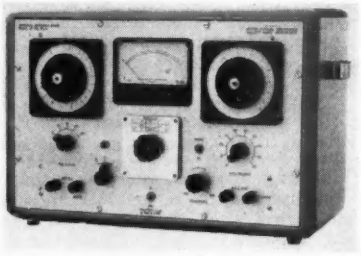
UNIVERSAL IMPEDANCE BRIDGE

(*Illustrated above right*)

This universal impedance bridge is a general-purpose instrument, covering a wide range of measurements for values of resistance, inductance and capacitance.

When used for resistance measurement, the instrument is connected as a Wheatstone bridge with an internal d.c. bridge voltage supply. In order to prevent self-heating, in particular of low wattage carbon resistors, the bridge voltage has been reduced to such a value that, at any measurement, the load of the resistor under test does not exceed 16mW. The out-of-balance voltage is amplified by means of a chopper amplifier and the indication is by means of a 4in meter, fitted with automatic overload protection.

Owing to the combination of a continuously variable resistance, and a decade resistance, an exceptionally long scale-length, namely, 60ft, is achieved. This arrangement is employed for resistance, capacitance and inductance measurement, and enables a higher reading accuracy.



As a capacitance bridge, the instrument is arranged as a modified De Saute's bridge, supplied with a 1kc/s bridge voltage from an internal oscillator. The dielectric loss is measured with a second variable control in combination with a 5-way switch. Provision is made for connecting an external d.c. source for applying a superimposed d.c. voltage to the capacitor under test. Null detection is by means of a tuned amplifier-detector, followed by a 4in indicator, fitted with automatic overload protection.

For the measurement of inductance, the instrument is converted into a Hay's bridge, the reactive standard consisting of a silvered mica capacitor; the same controls are used as for capacitance and power factor balance. By connecting an external d.c. source of supply, a current can be passed through the coil under test.

EE 8753 *for further details*

BURNDEPT LTD (121)

Erith, Kent.

CARTON CONTENTS MONITOR

(*Illustrated above right*)

The Burndept carton contents monitor type BE.251 employs a proximity switch which can sense at high speed metallic or non-metallic contents, provided the boxed article presents a sufficiently large change of electrical capacitance to the sensing probe.

The carton contents monitor kit comprises:

(a) One carton contents monitor BE.251
(b) One carton contents monitor ejector head BE.257
(c) Two carton contents monitor connectors BE.247
(d) One carton sensing head BE.258
(e) One contents sensing head BE.243

The items (d) (e) and sometimes (b) have to be designed specially to suit

HANOVER FAIR

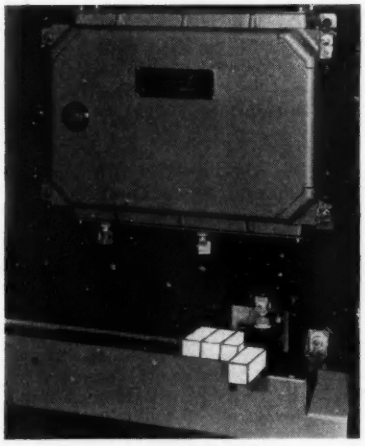
'Electronic Engineering' will occupy Stand 2 in Hall 13 at the Hanover Fair from 26 April to 13 May and visitors will be welcome.

each application depending on the size of cartons employed.

The ejector head and sensing probes are usually installed near the conveyor belt while the other units are mounted inside a cast instrument case which can be fixed to a nearby wall.

Basically, two proximity switches are used as detectors while the control unit co-ordinates their output and the action of the ejector head. One proximity switch senses (via its sensing probe) whether a box is full or empty while the other determines whether there are any boxes present on the conveyor belt. This latter refinement has been incorporated to prevent the ejector head operating unnecessarily when there are no boxes at all on the line, say, due to spacing or a production failure.

To give complete coverage for all production systems it is necessary to position the two sensing probes above each other. Where belt feed systems are used the lower probe (carton sensing probe) must be inserted within the flow line such that the articles are pressure fed over its surface.



The monitor BE.251 is capable of detecting a wide range of products in solid, powder, paste or liquid form. Foodstuffs, drugs, detergent powders, metallic pellets, etc., can be all checked before or after the carton has been sealed. Sometimes certain articles cannot possibly be detected by other methods; for example, cartons containing films could not be examined by a nucleonic method as 'fogging' of film would occur and only the capacitive method can be used in this case to determine whether a carton is full or empty. In certain cases the BE.251 can also be used for determining whether the cartons are correctly filled up to a predetermined level.

EE 8754 *for further details*

CATHODEON CRYSTALS LTD (7)

Linton, Cambridgeshire.

MINIATURE CRYSTAL OVEN

(Illustrated above right)

Specially designed for accurate temperature control of 2M type crystals, the Cathodeon miniature crystal oven is particularly suitable for close channel

mobile radio-telephone systems where precision frequency control is essential but space is at a premium. Frequency stability better than ±·0005 per cent over a wide temperature range is readily achieved. Compact design, low power consumption, and rapid heating from cold, are some of the special features.

The oven operates from a 6V or 12V supply with a power consumption of 4·6W and standard temperature settings of 75°C, 80°C and 85°C are available. The heating time is less than 5min from +20°C to +85°C. The weight is 1·5oz.

EE 8755 *for further details*

SUB-MINIATURE CRYSTALS

A new range of plug-in subminiature crystal units has been introduced. This unit, type 2MM, is especially suitable for use with transistors and other miniature components. They are available in a frequency range from 5 to 75Mc/s (fundamental 5 to 20Mc/s and series resonant overtone 15 to 75Mc/s) with a performance of ±·005 per cent from −55°C to 105°C

EE 8756 *for further details*

DAWE INSTRUMENTS LTD (66)

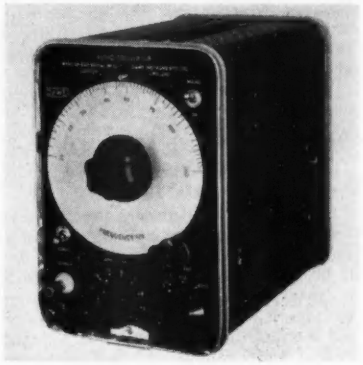
99 Uxbridge Road, Ealing, London, W.5.

TRUE R.M.S. VALVE-VOLTMETER

(Illustrated below)

Unlike the usual valve-voltmeters which are average or peak reading instruments calibrated to read r.m.s. values, the type 612 true r.m.s. valve-voltmeter measures accurately the effective value of waveforms other than sinusoidal. Accurate r.m.s. reading can be obtained for voltages or currents associated with non-linear devices or circuits. Thirteen voltage ranges are provided with full scale meter deflexions of 300μV, 1mV, 3mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V. The amplifier response does not vary more than ±3 per cent from 15c/s to 150kc/s and ±5 per cent 5c/s to 500kc/s.

EE 8757 *for further details*

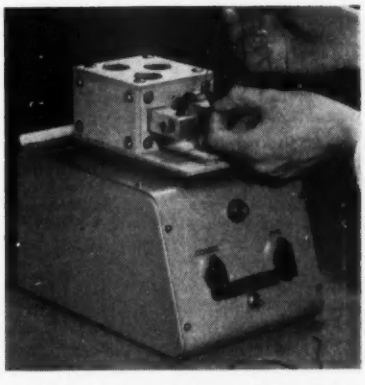


HIGH OUTPUT A.F. OSCILLATOR

(Illustrated above)

This oscillator is of the resistance capacitance tuned type covering the frequency range 20c/s to 20kc/s. A feature of the oscillator is the high output (6W) matching into a load impedance of 15Ω or 600Ω, i.e. ample power to drive loudspeakers or small vibration generators direct. Accuracy is ±1 per cent on the 200c/s to 2kc/s range with ±2 per cent accuracy on other ranges.

EE 8758 *for further details*



ELECTROTHERMAL ENGINEERING LTD (135)

270 Neville Road, London, E.7.

PRECISION BRAZING EQUIPMENT

(Illustrated above)

This equipment has been developed to provide an easily operated, portable and compact unit for use with silver brazing alloys. It is of especial use for the hard soldering of resistance wires, such as nickel chrome and related alloys, where soft solder is either difficult to use or has too low a melting point for the work

in hand, and where spot welding gives too weak a joint.

Although mainly designed for fine work (from ·001in diameter) the unit can be used to join wire as heavy as 10s.w.g. (0·128in diameter).

The consumption of the unit depends upon the control setting; the maximum is approximately 500W. Solder is heated by means of an expendable element which is easily replaced. Receptacles for flux and solutions for flux removal are conveniently placed for the operator, the solutions being heated. The equipment is suitable for use on any a.c. supply from 200 to 250V without adjustment, and other a.c. supplies to special order.

EE 8759 *for further details*

FORTIPHONE LTD (152)

92 Middlesex Street, London, E.1.

SUB-MINIATURE POTENTIOMETERS

The type VS32 sub-miniature potentiometer and s.p. switch is of extremely small dimensions and is intended for use in headborne hearing aids, etc. It is designed for frontal or edgewise mounting and is secured by a central screw and nut and has an overall diameter of 0·312in and depth of 0·15in. It can be supplied in resistance values between 1kΩ and 3MΩ with a power rating of 50mW.

The type PSR preset potentiometer is available for conventional wired or printed circuit applications. The overall diameter of 0·45in and the case depth 0·08in. The resistance range and power rating are the same as for the type VS32.

The type PSS is a preset sliding potentiometer of simple design and construction having an overall length of 1·1in and an overall width of 0·28in. The resistance range is 1kΩ to 3MΩ and the power rating 50mW.

EE 8760 *for further details*

GEO. L. SCOTT & CO. LTD (133)

Cromwell Road, Ellesmere Port, Cheshire.

LAMINATIONS AND CORES

A range of sub-miniature transformer laminations is now available covering overall dimensions from 1in by $\frac{1}{2}$in down to $\frac{1}{2}$in by $\frac{1}{4}$in, for use in transistor circuits and where space is at a premium.

Toroidal cores, using nickel iron materials made by the powder metallurgy process, are available on high temperature ceramic bobbins, to RCL 193 sizes, on which windings can be directly applied. The consistency of characteristics and the high performance to be gained by using these alloys is apparent where, for instance, matched pairs are needed for magnetic amplifiers. Silicon iron toroidal cores in materials of ·013in, ·004in and ·002in thickness are also available to RCL 193 as well as to customers' standards, for low and high frequency power sources.

Fast switching and high permeability tapes down to ·0003in thick are also produced on ceramic bobbins for switch matrices and other high performance magnetic devices.

EE 8761 *for further details*

HINCHLEY ENGINEERING CO. LTD (91)

Pans Lane, Devizes, Wiltshire

ISOLATING TRANSFORMERS

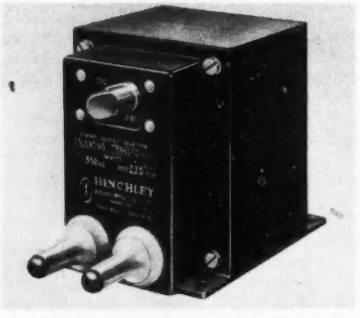
(Illustrated below)

In addition to a large range of transformers for radio and television applications, etc., a range of standard isolating and auto-transformers for laboratory, workshop and service department use will also be shown. These transformers are all provided with rapid-change fused output voltage selectors, and are optionally available with Mycalex snap-action terminals.

Of particular interest, in view of the growing number of domestic electrical appliances for use in the workshop and the garden, are two versions of the Hinchley 'Safetybox' which are portable isolating transformers enclosed in stout steel cases (either 1 : 1 ratio for isolation of existing equipment; or, preferably, 110V or 55V output with centre-point earthed).

These have been designed specifically for large-quantity production, so that the ultimate cost to the consumer will make safety a more economic necessity.

EE 8762 *for further details*



JAMES A. JOBLING & CO. LTD (158)

Wear Glass Works, Sunderland.

METAL OXIDE RESISTORS

These high precision, high stability resistors are made from 'Pyrex' brand rod to which a thin film of metallic oxide is fused. The core and film are inseparably impervious and stable under the most advance conditions and their noise level is extremely low.

The standard tolerance of these resistors is 1 per cent and they are manufactured to customers' exact requirements rather than to preferred values, in a range between 100Ω and 250kΩ, and in power ratings between 0·5W and 2W.

EE 8763 *for further details*

LABGEAR LTD (110)

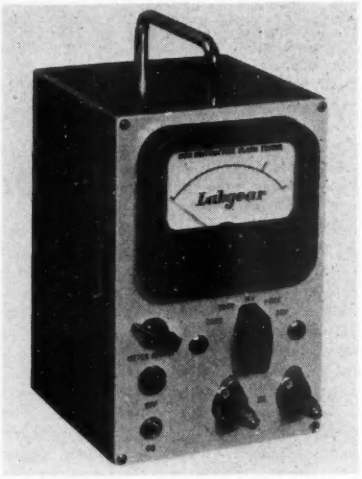
Willow Place, Cambridge.

NON-DESTRUCTIVE FLASH TESTER

(Illustrated above right)

This equipment is designed for testing the insulation of circuits and components such as low value capacitors.

The standard model provides a.c. test voltages of 250V, 500V, 1kV, 1·5kV and 2kV. A feature of the instrument is that it allows a component to be tested in



excess of its normal working voltage, and if breakdown should result, the component is completely undamaged and may be re-employed at a lower potential, which allows components to be graded without the risk of destruction.

EE 8764 *for further details*

LUSTRAPHONE LTD (111)

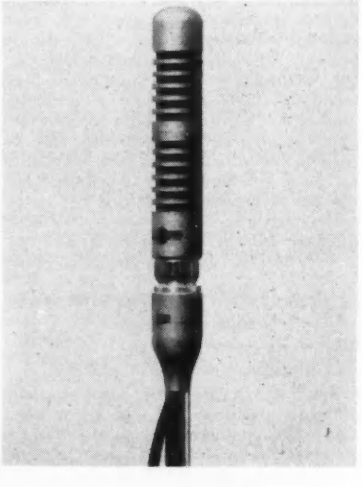
St. George's Works, Regent's Park Road, London, N.W.1.

STEREOPHONIC MICROPHONE

(Illustrated below)

This microphone unit consists of two identical ribbon velocity microphones mounted vertically in line. The top half of the unit, which contains one of the microphones, is so arranged that it can be continuously rotated through an angle of approximately 100° from the 'in line' position, thus enabling the optimum setting for any contingency (of stereophonic transmission, recording, broadcasting, sound re-inforcement etc.) to be achieved. The lower half of the microphone is placed in a fixed position.

The microphone is connected to a switch unit by means of a 4 way screw-type connector. The advantage of this method is that the sensitive microphone



head can be instantly detached and stored in a safe place, without disturbing the set-up and connexions to the main equipment.

A specially designed switch is provided with three positions:

(1) Off position in the centre.

(2) Stereo connexion on the extreme of one side.

(3) The other extreme position on the switch connects the two ribbon units in series and thereby changes the microphone into a straightforward ribbon velocity microphone of high sensitivity and a figure '8' polar characteristic.

A phase reversing switch is provided at the rear of the switch unit so as to give instantaneous changeover to achieve the correct phasing on any equipment.

When the microphone is set in position as described in (3) above, and with both units 'in-line', operation of the phase reversing switch changes the microphone into a noise eliminating microphone of substantial efficiency, responding only to a sound source at close distance.

In conjunction with the alternative positions of the phase switch, intermediate relative positioning of the microphone units gives a variety of directional effects which can prove beneficial in difficult acoustic conditions.

The impedance of each microphone unit in the standard model is 20Ω and the overall impedance of the combined instrument switched to the series position is 40Ω.

EE 8765 *for further details*

McMURDO INSTRUMENT CO. LTD (32)

Victoria Works, Ashtead, Surrey.

VALVEHOLDERS AND CONNECTORS

A new range of pen nib valveholders using single blank mouldings in both B9A and B7G versions for printed circuit and conventional wiring is available. These are designed to accept simple spring valve retainers, the fixing of which is integral with the metal mounting of the valveholder. In addition the valves can be screened by cheap rolled up screening cans which are a close fit around the valve envelope and are retained and electrically earthed by the spring retainer.

The Pakonector range of plugs and sockets has been added to by the introduction of an 8 way version which is similar in size to a B7G valveholder. The same cable connexion and potting service is available on the 8 way as on the original 18 way versions.

EE 8766 *for further details*

MULLARD LTD (77, 67)

Mullard House, Torrington Place, London, W.C.1.

110° CATHODE-RAY TUBES

Both 21in and 17in sizes are being produced, under the type numbers AW53-88 and AW43-88 respectively

The new 110° tubes are substantially shorter than the equivalent sizes of tubes currently in use, and will make possible reductions in the front-to-back dimensions of television receiver cabinets.

In the case of the 21in screen, the 110° tube is over 8¼in shorter than its 70° counterpart, and 5in shorter than a 90° type. The 17in 110° tube shows reductions of approximately 6¼in and 3in, respectively, over the equivalent size of 70° and 90° types.

The new tubes have high-efficiency metal-backed phosphors, and provide excellent brightness and contrast under high ambient light levels. They are electrostatically focused, and incorporate the 'straight' type of electron gun, which dispenses with an ion-trap magnet.

EE 8767 *for further details*

PAINTON & CO. LTD (29)

Kingsthorpe, Northampton.

MINIATURE HIGH STABILITY RESISTORS

These extremely small high stability carbon resistors (type 70) measure only ¾in by 1/10in (approximately) and are thus suitable for use in miniature transistorized equipments and particularly printed circuit board applications. The leads are pre-tinned to facilitate dip soldering. The resistance range covers standard values from 5Ω to 250kΩ at a tolerance of 5 per cent but tolerances of 1 per cent and 2 per cent can when necessary be provided over most of the range.

EE 8768 *for further details*

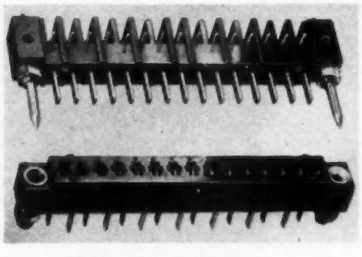
PRINTED CIRCUIT CONNECTORS

(Illustrated below)

A number of printed circuit connectors have been introduced including a stoutly constructed 15-way plug and socket fitted with steel dowels. In company with most of the Painton printed circuit connectors the contacts are on a 0·1in module.

Also in production is an edge connector available with up to 60 contacts in three groups of 20 with 0·1in centres, the contacts are of a unique and patented design and tests have shown that this form of contact permits a very long board insertion life.

EE 8769 *for further details*

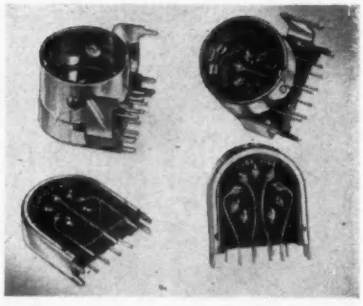


RIGHT-ANGLE VALVEHOLDERS

(Illustrated above right)

These components have been designed to permit horizontal mounting of valves, so facilitating the production of more compact printed circuit assemblies and simplifying heat sink arrangements.

The contacts are silver-plated beryllium copper and are of such a length to suit the most commonly used printed board thicknesses. The correct insertion and withdrawal pressures are maintained with minimum contact resistance.



EE 8770 *for further details*

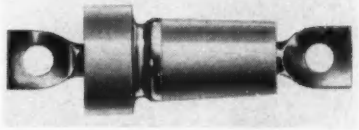
STEATITE AND PORCELAIN PRODUCTS LTD (76)

Stourport-on-Severn, Worcestershire.

TERMINAL SEALS

(Illustrated below)

Following the preliminary announcement last year, the new range of terminal seals will be shown designed to conform with the requirements of the



Services' specification PCL 331. These are made of a high alumina ceramic and the stems are firmly sealed into position by means of glaze fusion. External metallized bands are provided by a quality approved nickel metallizing process to permit of soft-soldering directly into metal cans for all hermetic sealing applications.

The standard ranges of nickel metallized seals, quality approved to the H1 category, are still available from stock and a sample making service can provide prototypes of new designs at short notice. A new emphasis has been placed on improved facilities for assembling metallized ceramic products with appropriate metal fittings to cover a wide variety of applications ranging from miniature lead-outs to large, high-voltage capacitor terminals.

EE 8771 *for further details*

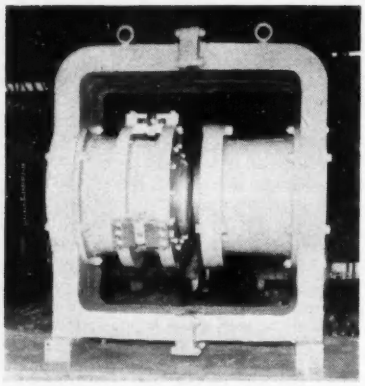
SWIFT LEVICK & SONS LTD (156)

Clarence Steel Works, Sheffield 4.

LARGE PERMANENT MAGNETS

(Illustrated overleaf)

Very large and stable permanent magnets are now being produced with fields of high homogeneity for nuclear magnetic resonance purposes. The photograph shows such a magnet designed and produced for research at Leeds University. This magnet weighs 2 tons 6 cwt, measures 4ft by 3½ft by 2ft overall, and is permanently energized by Columax alloy, which is the most stable and



powerful magnet material produced commercially anywhere in the world. The magnet has a gap field strength of 9 700 oersted over a gap volume of 1·4in long by 10in diameter, and the uniformity of field is better than 1 part in 10^6 over a central volume of about 1cm³. Special mechanical adjustments are provided on one of the iron pole pieces, thus enabling restricted movement of the pole face in any plane for final uniform adjustment of the gap field strength.

A one-sixth scale model of this magnet will be exhibited.

EE 8772 *for further details*

TELEPHONE MANUFACTURING CO. LTD (21)

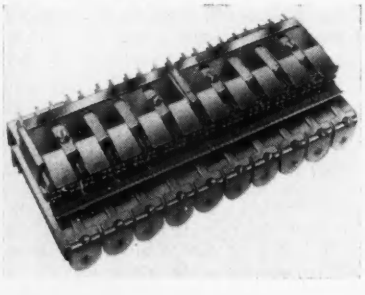
Hollingsworth Works, London, S.E.21.

MULTIPLE RELAY

(Illustrated below)

The new TMC 10-way multiple relay will be shown. In this new relay many unique and novel manufacturing methods have been employed which will bring about a low cost together with an increase in reliability. The TMC multiple relay employs a common yoke integral with mounting brackets, and is intended to replace telephone type relays in control circuits where cost is of prime importance.

Contact springs of phosphor-bronze, with silver bimetal contacts in the crossed radii technique, and automatic machine adjustment and card operation, ensure a constant contact pressure hitherto available only in the expensive precision relays. An efficient magnetic circuit ensures that magnetic interaction between relays is virtually non-existent, while the common yoke mounting brackets greatly reduce the number of piece parts and eliminate the need for separate mounting pieces.



The price of this multiple relay is such that it will frequently be found more economical to fit a 10-way unit rather than a lesser number of conventional relays.

EE 8773 *for further details*

WHITELEY ELECTRICAL RADIO CO. LTD (81)

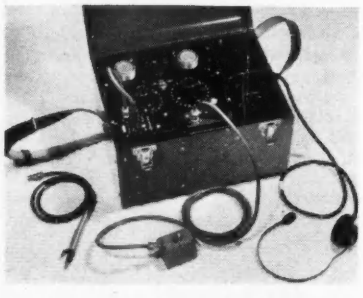
Radio Works, Victoria Street, Mansfield, Nottinghamshire.

CABLE TEST SET

(Illustrated below)

This tester locates the position of breaks or short-circuits in sheathed multiple conductor cables to within a fraction of an inch. Repairs can then be carried out with a minimum of disturbance to the cable sheath.

The principle of operation is as follows: In the case of a broken conductor



an a.f. voltage is applied between one end of the conductor and earth; the electrostatic field between the live section of the conductor and earth can then be detected by running a capacitive probe along the cable. The probe is connected to the input of a portable transistor amplifier, which feeds a headset thus giving an audible indication of the break position. All other conductors in the cable should be earthed, other than the one being tested.

An inductive probe is used in place of the capacitive probe for locating shorts between conductors. The oscillator will feed a signal to the conductor only up to the point where the short occurs and the probe will detect the electromagnetic field up to this point.

The test panel is provided with rotary switches to select individual conductors in the cable. Conductors other than the one selected are earthed. Sockets are fitted to accommodate the cable plugs. For initial determination of a faulty conductor a lamp type continuity tester is provided.

The valve oscillator is battery operated and has an output power of 10mW with an output impedance of 300Ω. Its frequency is 1kc/s ±2½ per cent. The type of oscillation can either be continuous or interrupted depending upon the setting of the potentiometer.

The transistor amplifier operates from a 4½V battery contained in the case and has an overall gain of 70dB when terminated with a 300Ω non-inductive load.

The inductive probe is tuned to 1kc/s ±2½ per cent.

EE 8774 *for further details*

THE ZENITH ELECTRIC CO. LTD (8)

Zenith Works, Villiers Road, Willesden Green, London, N.W.2.

REGULATING TRANSFORMERS

(Illustrated below)

A new 'Variac' model 50-B/2B having a dual output will be shown. This is designed for a 230V 50c/s supply providing an output variable between zero and 270V, maximum rated current 20A, which represents the total that may be taken from the two brushes but the load can, of course, be distributed to suit an application calling for example; Output No. 1—12A, Output No. 2—8A. The two brush, dual output 'Variacs' have been available in the series '100' and 'V30H' for some time and also in the smaller toroidal range in the series '200'.

These smaller types have now been re-designed using parts from the 'V5' series, and allows a more compact example to be produced.

EE 8775 *for further details*

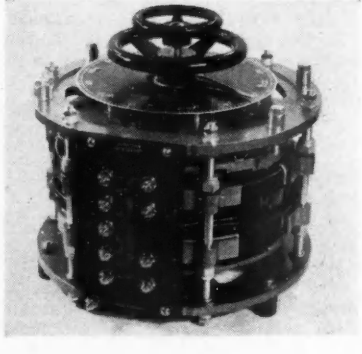
EARTH LOOP TESTING EQUIPMENT

This is housed in a metal cabinet complete with carrying handle and a pocket for an inlet cable and plug adaptor. It is designed to completely cover all tests required by I.E.E. Regulation No. 507 and to operate from a standard single-phase supply giving an output of 25A at any voltage between zero and 40V.

A Zenith double wound, step down transformer is used with a 'Variac' across the primary, a double range rectifier voltmeter being provided together with an ammeter, there is a 3-pin 13A and a 3-pin 15A outlet socket on the front of the casing for earth core tests of portable appliances. The 40V is available for most tests but 6V is included as this may be more convenient for short earth loops such as portable tools and other similar appliances.

A link is fitted for testing fixed appliances for which the 6V would be employed as the earth lead is comparatively short and should not exceed 0·1Ω representing about 3V.

EE 8776 *for further details*



Short News Items

Interlab Inc. of New York have instituted a new type of marketing and consulting service for members of the British electronic industry, the purpose of which is to help British manufacturers to explore the U.S. market for their products, and set up marketing and licensing arrangements or negotiate manufacturing licences in respect of American electronic products. This idea was tried out on an experimental basis in the spring of 1958 and was the outcome of the Company's four years of marketing experience in Britain. Interlab work closely with the Commercial Department of the British Consulate in New York as well as with the Trade Promotion Centre to give a more specialized service. Further information can be obtained by applying direct to Interlab Inc., 437 Fifth Avenue, New York 16, N.Y., U.S.A.

Marconi's Wireless Telegraph Co. Ltd have been awarded contracts from the Norwegian P.T.T. Administration and the Royal Board of Swedish Communications for a combined multi-channel radio-telephone and television link between the Norwegian capital, Oslo, and Karlstad (Sweden). A further section, carrying multi-channel radio-telephony only, is to be installed in Sweden between Karlstad and Arvika. Between Oslo and Karlstad two two-way paths and one reversible one-way path are to be constructed. Both will operate in the s.h.f. band (4 000Mc/s). One of the two-way paths will carry 600 channels of radio-telephony while the reversible single-path system will carry television signals. The second two-way path is to function as a standby for either. Broadcast speech circuits and control and supervisory signals will be transmitted via an additional radio link operating in the 400Mc/s band. The path carrying the television signals will enable programmes emanating from Oslo to be fed into the Swedish link and so into the Eurovision network; by reversing the path, Oslo can take programmes from Sweden or the Eurovision network. On the Norwegian side of the border, the twin two-way and the single reversible terminal equipments will be sited at Oslo, with the first repeater at Tryvasshogda and a second at Runddellen. In Sweden, one repeater will be sited at Blabarskullen with a terminal at Karlstad. The section from Karlstad to Arvika (multi-channel radio-telephony only will also be a twin-path system with one path carrying 600 telephone channels and the second as a standby. The distances involved are: Oslo to Karlstad, 190km, and Karlstad to Arvika, 40km. A survey of the sites has been carried out and the system is expected to be in operation by May 1960.

The Radio Industry Council announces the award of six premiums of 25 guineas each for articles on radio and electronics published in the technical press during 1958. The premiums are awarded as follows:

'A New High-Frequency High-Power Amplifier' by V. J. Tyler, B.Sc., A.M.I.E.E. (Marconi's Wireless Telegraph Co. Ltd). Published in *The Marconi Review*, 3rd Quarter, 1958.

'New Types of D.C. Amplifiers'—Parts 1 and 2—by D. J. R. Martin, B.Sc., A.Inst.P. (The Mining Research Establishment). Published in *Electronic and Radio Engineer*, Jan./Feb. 1958.

'A Survey of Microwave Radio Communication' by W. J. Bray, M.Sc. (Eng.), M.I.E.E. (Post Office Engineering Department). Published in *Electronic Engineering*, May 1958.

'All Travelling-Wave Tube Systems' by S. Fedida, B.Sc.(Eng.)(Hons.), A.C.G.I., A.M.I.E.E. (Marconi's Wireless Telegraph Co. Ltd). Published in *Electronic Engineering*, May 1958.

'Electronic Developments at Very Low Temperatures' by E. Mendoza, M.A., Ph.D. (Manchester University). Published in *British Communications and Electronics*, April 1958.

'Analogue Computation' by E. Lloyd Thomas, B.Sc., A.C.G.I., M.I.E.E., A.F.R.Ae.S. (R. B. Pullin & Co. Ltd). Published in *British Communications and Electronics*, May 1958.

The number of articles submitted for consideration was fifty-nine. The presentation of awards will be made at a luncheon on Wednesday, 15 April, by the new director of the R.I.C., Air Marshal Sir Raymond G. Hart, with Mr. W. M. York, chairman of the public relations committee, presiding.

Ampex Electronics Ltd, a new subsidiary of the Ampex Corporation, California, will start the manufacture in Britain of magnetic tape recording equipment. The factory will be in Reading with initial production scheduled for early summer of instrumentation magnetic tape equipment having applications in many industrial and research fields. Heading the Company, a wholly owned subsidiary, will be Dr. Peter Axon, formerly of the research department of the BBC, who is an authority on audio and video magnetic recording research and equipment.

Gilmoor Control Systems Limited of London, a Company owned by Electroflo Meters Co. Ltd, is engaged in the manufacture of a remote control and indication system employing a v.h.f. radio link. The system is employed for remote control and the position indication of sixteen water pumps raising and transferring water from an oasis to an installation of the Qatar Petroleum Company in the Persian Gulf. The control signalling takes place at 173·5Mc/s while indications back to the control station are transmitted at 160·3Mc/s with two-way speech communication on a frequency modulated channel at 167Mc/s. The control station and the controlled pumps are seven miles apart.

The Electronic Engineering Association held their annual general meeting in London on 23 February and elected Mr. L. T. Hinton (Standard Telephones & Cables Ltd) chairman in succession to Mr. F. S. Mockford (Marconi's Wireless Telegraph Co. Ltd). Mr. R. R. C. Rankin (Mullard Ltd) was elected vice-chairman. Mr. Hinton's connexion with radio communication goes back to experience in the Royal Engineers (Signals) in the 1914-18 war. He is now the manager responsible to his Company for all relations with trade associations, commercial and technical, and contractual relations with the Government through the Federation of British Industries. The Council was enlarged from twelve to fourteen members. All the 1958 members were re-elected with the exception of Kelvin & Hughes Ltd, who stood down, and newly-elected members were Automatic Telephone & Electric Co. Ltd, Siemens Edison Swan Ltd, and Ultra Electric Ltd. Members not standing for election besides Kelvin & Hughes Ltd, were G.E.C., Marconi Instruments Ltd, Marconi International Marine, Philips Electrical Ltd and Rank Cintel Ltd.

The Institution of Electrical Engineers held their annual dinner at Grosvenor House on Thursday, 26 February, 1959, with the President, Mr. S. E. Goodall, in the chair. The principal guest was the Lord Chancellor, the Rt. Hon The Viscount Kilmuir, who proposed the toast of 'The Institution', to which the president replied. The toast of 'Our Guests' was proposed by Mr. T. E. Goldup (Immediate Past-President) and the reply was given by Sir Norman Kipping (Director-General, Federation of British Industries).

Erratum. In the article 'An Introduction to Matrices' by J. S. Bell and K. Brewster in the February issue, the two lines preceding the 'Conclusion' on page 102 should read:

$$= \frac{10^3}{0{\cdot}198\angle 1^\circ}$$
$$\simeq 5{\cdot}05\text{k}\Omega$$

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Date: 22 April. Time: 6.30 p.m.
Held at: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.
Lecture: The Application of Magnetic Resonance to Solid State Electronics.
By: D. J. E. Ingram.

South Midlands Section

Date: 2 April. Time: 7.0 p.m.
Held at: Winter Gardens, Malvern.
Lecture: A Simple High-Quality F.M. Broadcast Receiver employing a Pulse-rate Discriminator.
By: P. J. Baxandall.

Scottish Section

Date: 17 April. Time: 6.30 p.m.
Held at: Department of Natural Philosophy, The University, Drummond Street, Edinburgh.
Annual General Meeting.
Lecture: Stereophonic Sound and Electrostatic Loudspeakers.
By: D. T. N. Williamson.

Merseyside Section

Date: 22 April. Time: 7 p.m.
Held at: University Club, Liverpool.
Annual General Meeting.

North Eastern Section

Date: 8 April. Time: 6 p.m.
Held at: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne.
Lecture: Radio Exploration of the Galaxy.
By: J. Baldwin.

North Western Section

Date: 2 April. Time: 6.30 p.m.
Held at: Reynolds Hall, College of Technology, Sackville Street, Manchester 1.
Lecture: Principles of Transistor Circuitry.
By: B. R. A. Bettridge.

BRITISH SOUND RECORDING ASSOCIATION

Date: 17 April. Time: 7.15 p.m.
Held at: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.
Lecture: The Quest for Quality.
By: P. Ford.

THE INSTITUTION OF ELECTRICAL ENGINEERS

All London meetings, unless otherwise stated, will be held at the Institution, commencing at 5.30 p.m.

Ordinary Meeting

Date: 2 April.
Lecture: Women in Engineering.
Opened by: Sir Willis Jackson.
Date: 23 April.
Kelvin Lecture: The Geophysical Year 1957-58.
By: Sir David Brunt.

Measurement and Control Section

Date: 7 April.
Lecture: An Electron Trajectory Tracer for use with the Resistance Network Analogue.
By: M. E. Haine and J. Vine.
Date: 21 April.
Discussion: The Problem of Maintenance of Electronic Equipment in the Process Industries.

Radio and Telecommunication Section

Date: 8 April.
Lecture: The New Post Office 700-Type Telephone.
By: F. E. Williams and F. C. Carter.
Date: 17 April.
Lecture: Engineering Aspects of Commercial Television Programme Presentation.
By: T. C. Macnamara and B. Marsden.
Date: 27 April.
Lecture: The Field Strengths Required for the Reception of Television in Bands I, III, IV and V.
By: G. F. Swann.

Utilization Section

Date: 16 April.
Lecture: An Electromagnetic, Variable-Ratio, Torque Convertor.
By: D. O. Bishop and G. S. Brosan.

East Midland Centre

Date: 7 April. Time: 6.30 p.m.
Held at: College of Arts and Crafts, Nottingham.
Lecture: Subscriber Trunk Dialling.
By: D. A. Barron.

Cambridge Radio and Telecommunication Group

Date: 14 April. Time: 7 p.m.
Held at: Cavendish Laboratory, Free School Lane, Cambridge.
Lecture: Designing Electronic Products.
By: J. R. Brinkley.
Lecture: The Application of Counting Techniques: and Some Unusual Industrial Talks.
By: C. C. H. Washtell.
Lecture: Measurement of Mechanical Parameters using Electrical Screening.
By: B. E. Noltingk.
Lecture: Some Aspects of Pulse Generation, Recording and Analysis.
By: J. Barron.
Lecture: An Unusual Circuit Element.
By: R. Nettleship.
Lecture: Some Features of Multi-Channel Recording in Electromedicine.
By: N. Bett.

East Anglian Sub-Centre

Date: 20 April. Time: 7.30 p.m.
He'd at: Assembly House, Norwich.
Annual General Meeting.
Lecture: High-Quality Sound Reproduction.
By: J. Moir.

North-Eastern Centre

Date: 13 April. Time: 6.15 p.m.
He'd at: Royal Station Hotel, Newcastle upon Tyne.
Annual General Meeting and Conversazione.

North-Eastern Radio and Measurement Group

Date: 6 April. Time: 6.15 p.m.
Held at: Rutherford College of Technology, Newcastle upon Tyne.
Annual General Meeting and Film Evening.

North Midland Centre

Date: 7 April. Time: 7 p.m.
Held at: Royal Station Hotel, York.
Lecture: The Relation between Picture Size, Viewing Distance and Picture Quality.
By: L. C. Jesty.

Sheffield Sub-Centre

Date: 15 April. Time: 6.30 p.m.
Held at: Grand Hotel, Sheffield.
Lecture: Subscriber Trunk Dialling.
By: D. A. Barron.

North-Western Centre

Date: 7 April. Time: 6.15 p.m.
Held at: Engineers' Club, 17 Albert Square, Manchester.
Lecture: H.V. D.C. Transmission, with special reference to the Cross Channel Cable.
By: F. J. Lane.

North Ireland Centre

Date: 14 April. Time: 6.30 p.m.
Held at: David Keir Building, Queen's University, Stranmillis Road, Belfast.
Lecture: The Use of Analogue Computing Elements in the Design of Automatic Control Systems.
By: Professor J. C. West.

South-West Scotland Sub-Centre

Date: 22 April. Time: 7 p.m.
Held at: The Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow, C.2.
Lecture: A Train Performance Computer.
By: E. Bradshaw, M. Wagstaff, F. Cooke.

South Midland Radio and Measurement Group

Date: 27 April. Time: 6 p.m.
Held at: James Watt Memorial Institute, Birmingham.
Lecture: Stereophonic sound.
By: K. N. Hawke.

North Staffordshire Sub-Centre

Date: 16 April. Time: 7 p.m.
Held at: Duncan Hall, Stone.
Lecture: Subscriber Trunk Dialling.
By: D. A. Barron.

Southern Centre

Date: 8 April. Time: 6.30 p.m.
Held at: S.E.B. Canteen, Drayton, Portsmouth.
Annual General Meeting.
Lecture: Rockets and Satellites.
By: R. L. F. Boyd.

Western Centre

Date: 13 April. Time: 6 p.m.
Held at: St. Mary's College, Cheltenham.
Lecture: Transistors in Communication and Control Equipment—A General Survey.
By: E. Wolfendale.

THE TELEVISION SOCIETY

Date: 23 April. Time: 7 p.m.
Held at: Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2.
Lecture: Design of Experimental Tuners for Bands 4 and 5 Television Receivers.
By: K. H. Smith.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Date: 28 April. Time: 6 p.m.
Held at: Manson House, Portland Place, London, W.1.
Lecture: Measurements in the Photographic Industry.
By: M. E. F. Howarth and P. B. Watt.

PUBLICATIONS RECEIVED

THE NICKEL BULLETIN, JANUARY 1959, contains abstracts which give an apt illustration of the immense importance of nickel in every branch of industry. In the general field of nickel plating, reference is made, for example, to electrodeposition of black nickel, tin-nickel and hard carbide/nickel coatings. The section dealing with non-ferrous alloys includes abstracts of papers on physical and magnetic properties and the influence of nickel content of copper alloys on susceptibility to intergranular cavitation. The issue also contains the first of the quarterly reviews of recent patent literature. The Mond Nickel Co. Ltd, Thames House, Millbank, London, S.W.1.

DIGITIZERS AND OTHER EQUIPMENT FOR DATA PROCESSING is a publication by Hilger and Watts dealing mainly with digitizers which are for use when measurements of mechanical movements which may be the analogues of variables, are wanted in digital form. Hilger and Watts Ltd., 98 St. Pancras Way, Camden Road, London, N.W.1.

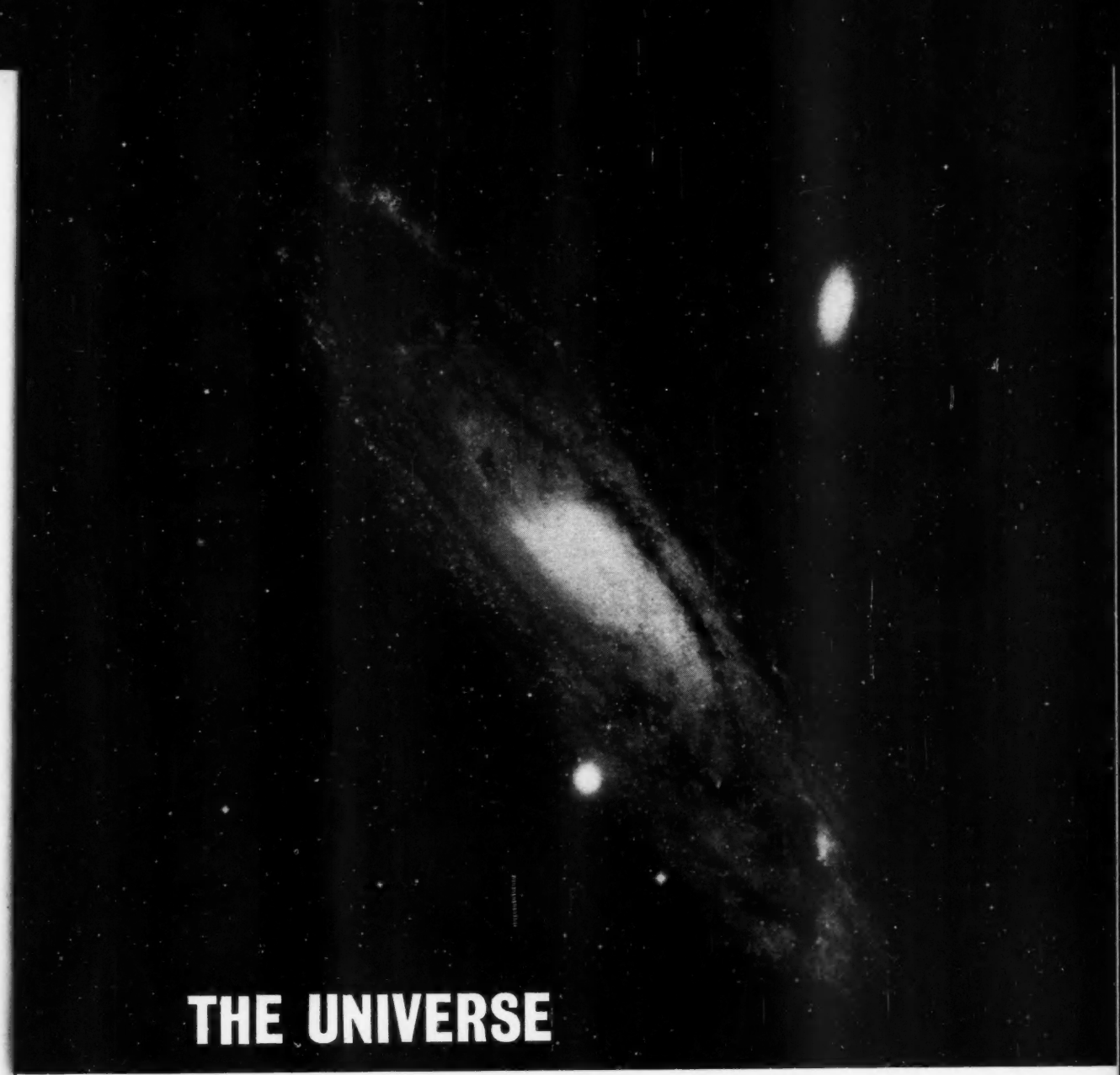
ABRIDGED VALVE DATA is a quick reference brochure, which is issued annually and gives abridged data for all English Electric Valves up to the date of publication. Technical Publications Department, English Electric Valve Co. Ltd, Chelmsford, Essex.

FILMS FOR INDUSTRY (1959-1960) EDITION supersedes all earlier editions of this catalogue and includes a large number of newly acquired films from various sources. The 612 films listed in this catalogue have been selected under the guidance of an Advisory Panel whose members include representatives from industry and Government Departments concerned with industry. Central Office of Information, Hercules Road, Westminster Bridge Road, London, S.E.1. Price 2s. 6d.

PERMANENT MAGNETS SUMMARIZED by F. G. Tyack, A.M.I.E.E., is a booklet recently prepared by James Neill & Company (Sheffield) Limited, manufacturers of 'Eclipse' Permanent Magnets, Magnetic Chucks and Magnetic Tools, and deals with the application of permanent magnets. This publication contains technical information on magnet design and materials and its contents are in convenient sequence for reference, while the illustrations and technical diagrams are captioned for easy reading and reference.

AN APPLICATION REPORT ON D.C. POWER SUPPLY CIRCUITS USING SILICON RECTIFIERS has been published by Texas Instruments Limited. This is the fourth in the series and draws attention to the particular design features of circuits using silicon rectifiers. The more common single-phase and three-phase rectifier circuits are described. Design procedures are discussed for circuits using capacitor-input and choke-input filters and for additional filter sections. For convenience, graphs used in the design procedures are collated at the end of the report. Texas Instruments Limited, Dallas Road, Bedford.

CHILTON STYLE 'C' ROTARY SWITCHES catalogues a very large number of different switches, and a great many accessories in this third edition by Chilton Electric Products Ltd, Hungerford, Berks.



THE UNIVERSE

– MAN'S ORBIT?

As time goes on, will man conquer all things . . . will the whole universe be his orbit?
This we do know, that to guide his progress in the physical sciences accurate instrumentation plays an ever-increasing role. And we who serve the instrument industry will also progress to provide exactly those specialised materials and components the instrument designer needs, and upon which the efficiency of so much modern equipment inevitably depends.

★ Precision drawn resistance wires · Nickel cathode tubes · Grid support wire · Contacts and contact springs · Rhodium electrodeposits · Silvered mica capacitors and plates · Fine fuse wires · Platinum: rhodium-platinum thermocouples · Mallory 73 Beryllium Copper wire and strip · Bourdon, capillary and pointer tubes · Wires for resistance thermometry. Silver brazing alloys.

Specialised Products of

Johnson Matthey

JOHNSON, MATTHEY & CO., LIMITED, HATTON GARDEN, LONDON, E.C.1. Telephone: Holborn 6989
Vittoria Street, Birmingham, 1. Telephone: Central 8004
75-79, Eyre Street, Sheffield, 1, Telephone: 29212
E 81

ELECTRONIC ENGINEERING assure . . .

Un tirage total payé de plus de 11 000 exemplaires par mois.

Une diffusion s'étendant à 86 industries dans 70 pays.

Un Service d'Aide aux Lecteurs qui transmet, aussitôt reçues, les demandes de renseignements concernant les annonces.

Marché Commun Européen

La diffusion mondiale d'ELECTRONIC ENGINEERING s'étend, en particulier, aux pays du Marché Commun Européen, c'est à dire la France, l'Allemagne Occidentale, les Pays-Bas, l'Italie, la Belgique et le Luxembourg.

On estime à 250,000,000 le nombre de consommateurs potentiels du Marché Commun Européen. Ce nombre augmentera encore considérablement lorsque la Zône Européenne De Libre-Echange (qui comprendra le Royaume-Uni et les pays Scandinaves) sera établie. L'Electronique contribuera alors à la production du matériel nécessaire à l'approvisionnement de cet énorme marché.

ELECTRONIC ENGINEERING compte déjà plus de 1600 abonnés directs en Europe. A mesure que les échanges de produits et de services s'intensifieront, notre revue sera l'objet, de la part des hommes de science et des ingénieurs-électriciens d'Europe, d'une demande accrue en conséquence.

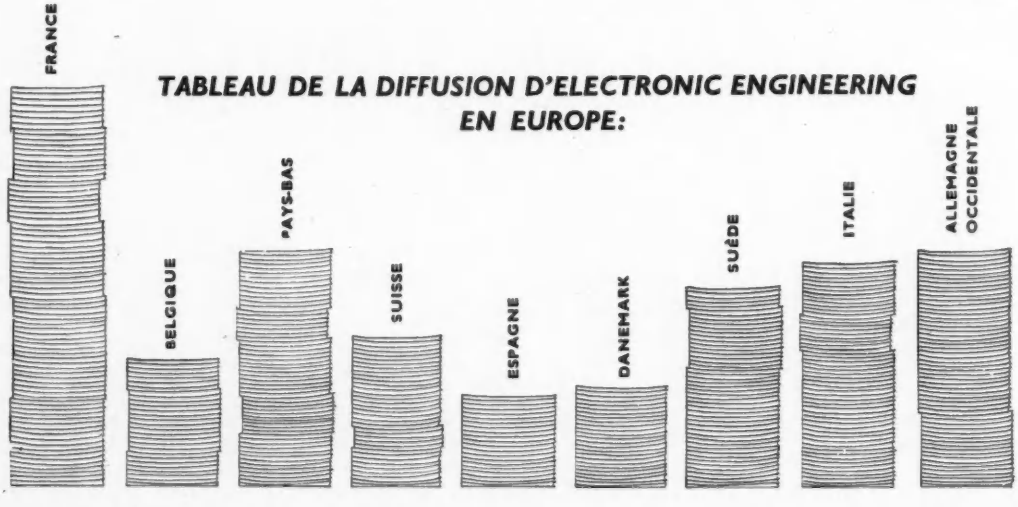
Pour plus amples renseignements s'adresser au ADVERTISEMENT MANAGER:—

Electronic Engineering

28 ESSEX STREET, STRAND, LONDON, W.C.2, ENGLAND

Telegrams: LECTRONING ESTRAND LONDON Telephone: CENTRAL 6565

TABLEAU DE LA DIFFUSION D'ELECTRONIC ENGINEERING EN EUROPE:



Le Salon BRITANNIQUE DE LA PIÈCE DÉTACHÉE ÉLECTRONIQUE

Description, basée sur des renseignements fournis par les fabricants, d'un choix de pièces détachées qui seront exposées au Salon de la Fédération britannique des Fabricants de Pièces Détachées et Accessoires radio-électriques et électroniques, à Grosvenor House et à Park Lane House, Londres, du 6 au 9 avril 1959.
(*Les chiffres entre parenthèses se rapportent aux numéros des stands*). (*Traduction des pages 236 à 240*)

AVO LTD (73)

Avocet House, 92-96 Vauxhall Bridge Road, London S.W.1

MACHINE À BOBINER

Une nouvelle machine à bobiner sera exposée par cette société. Cette machine est capable d'enrouler des bobinages en couches superposées presque parfaites, sans l'emploi d'un moyen quelconque d'interfoliage. Le couplage mécanique normal entre la poupée fixe et la pièce transversale de la machine a été supprimé et toutes deux sont actionnées par des moteurs indépendants dont les vitesses respectives sont commandées électroniquement par une tête de sondage qui contrôle l'angle d'avance du fil de façon à assurer, autant que possible, que chaque tour de fil soit posé avec précision auprès du tour précédent.

Le coefficient d'encombrement considérablement amélioré des enroulements que garantit cette machine donne un rendement électromagnétique maximum. Ce coefficient est d'une importance particulière dans le cas de pièces comme les relais et les solénoïdes, du type miniature surtout. La conformation rectilinéaire beaucoup plus précise des enroulements bobinés par cette machine augmente les possibilités d'emploi de bobinages non-soutenus là où des formes de soutien étaient nécessaires auparavant.

EE 8751 *pour plus amples renseignements*

BRAYHEAD (ASCOT) LTD (167, 169)

Full View Works, Kennel Ride, Ascot, Berkshire

DISPOSITIFS D'ACCORD DE TÉLÉVISION

(*Illustration à la page 235*)

Le dispositif d'accord PB1 constitue un accessoire à 10 positions de grande efficacité et de construction compacte. Il permet la charge univoie ou multivoies, une gamme d'accords précis et le son à fréquence modulée sur une ou trois positions. Il offre un haut niveau de rendement en ce qui a trait à l'amplification, au glissement, au bruit, à la stabilité et à la forme de réponse.

Les dispositifs d'accord PB3 et PB4 sont le produit des efforts conjugués des sociétés Plessey et Brayhead. Ils ont le même encombrement réduit que le PB1, fournissant 14 voies, en ce qui concerne le PB3, et 18 voies pour le PB4, tous deux offrant une position supplémentaire permettant d'ajouter, s'il y a lieu, un raccord hyperfréquences.

Le branchement télévision-modulation de fréquence peut être effectué soit par un interrupteur plat fixé sur la rallonge de broche arrière soit par un interrupteur auto-nettoyeur à cames. Ce dernier est fourni en modèles pour accord modulation de fréquence univoie ou multivoies.

L'utilisateur a le choix de nombreux autres avantages comprenant:
filtre f.i. imprimé, accord de fréquence modulée univoie ou multivoies, composantes d'isolement incorporées, circuit d'accord précis pour bande large ou étroite, bobines d'accord d'antenne réglables, circuit d'entrée à couplage inductif, circuit de sortie f.i. à double accord, charge univoie ou multivoies, circuit de sortie f.i. à double fréquence, commutation de sensibilité incorporée, commutation d'antenne incorporée.

On peut, par ailleurs, employer le tube PCC89 ou la combinaison 30L15/30C15.

En plus des voies normales anglaises, ces dispositifs peuvent être pourvus de voies pour les systèmes de la Commission fédérale des communications (E.U.) ou du Comité consultatif international des radio-communications, ainsi que pour toutes les autres voies spéciales utilisées à l'étranger.

EE 8752 *pour plus amples renseignements*

FOIRE INTERNATIONALE DE HANOVRE

"Electronic Engineering" occupera le Stand 2, dans la Salle 13, à la Foire Internationale de Hanovre, du 26 avril au 13 mai 1959, et les visiteurs y seront les bienvenus.

BRITISH PHYSICAL LABORATORIES (88)

Houseboat Works, Radlett, Hertfordshire

PONT D'IMPÉDANCES UNIVERSEL

(*Illustration à la page 236*)

Ce pont d'impédances universel est un instrument pouvant effectuer une série étendue de mesures de valeurs de résistance d'inductance et de capacité.

Lorsqu'il est employé pour les mesures de résistance, il est relié, sous forme de pont Wheatstone, à une tension continue de pont intérieure. Afin d'empêcher l'auto-échauffement, en particulier de résistances au charbon de faible puissance, la tension de pont a été réduite à une valeur qui empêche—quelle que soit la mesure effectuée—la charge de la résistance sous examen de dépasser 16 mW. La tension déséquilibrée est amplifiée par un amplificateur écrêteur, l'indication s'effectuant sur un enregistreur de 10 cm muni d'une protection automatique de surcharge.

En alliant une résistance à variation continue à une résistance de décades, une longueur d'échelle exceptionnellement longue (18,3 mm) peut être obtenue. Ce procédé est employé pour les mesures de résistance de capacité et d'inductance et il donne une grande précision de lecture.

Lorsque l'instrument est employé comme pont de capacité, il est disposé sous forme de pont de Saute modifié, alimenté par un oscillateur intérieur en tension de pont de 1 kHz. La perte diélectrique est mesurée par une seconde commande variable combinée avec un interrupteur à cinq directions. Il est également possible de brancher une source de courant continu externe afin de pouvoir appliquer une tension continue superposée à la capacité sous essai. La détection de zéro s'effectue au moyen d'un amplificateur-détecteur accordé suivi par un indicateur de 10 cm, muni d'une protection de surcharge automatique.

Pour mesurer l'inductance, l'appareil est changé en pont de Hay, l'étalon réactif consistant en un condensateur au mica argenté. Le contrôle est le même que pour l'équilibre de capacité et de

facteur de puissance. En branchant une source extérieure d'alimentation en continu, on peut faire passer une tension par le bobinage sous examen.

EE 8753 *pour plus amples renseignements*

BURNDEPT LTD (121)

Erith, Kent

DÉTECTEUR DE CONTENU POUR BOITES EN CARTON

(Illustration à la page 237)

Le Détecteur de contenu BURNDEPT Type BE.251 utilise un interrupteur de proximité qui détecte avec grande rapidité le contenu métallique ou non-métallique de boîtes en carton, à condition que ce contenu présente à la sonde de détection un changement de capacité électrique suffisamment important. L'appareillage de détection du contenu de boîtes en carton comprend:

(a) Un détecteur de contenu BE 251
(b) Une tête d'éjection de détecteur de contenu BE 257
(c) Deux connecteurs de détecteur de contenu BE 247
(d) Une tête de sondage de carton BE 258
(e) Une tête de sondage de contenu BE 243

Les accessoires (d), (e) et, parfois, (b) sont construits sur commande pour répondre à chaque application particulière, c'est à dire en fonction des dimensions des cartons employés.

La tête d'éjection et les sondes de détection sont généralement montées près de la courroie de transmission, tandis que les autres éléments sont montés à l'intérieur d'une boîte à instruments pouvant être fixée sur un mur voisin.

Fondamentalement, les deux interrupteurs de proximité servent de détecteurs tandis que l'élément de contrôle coordonne leurs fonctions avec l'action de la tête d'éjection. L"un des interrupteurs de proximité vérifie (au moyen de sa sonde de détection) si une boîte est vide ou pleine, cependant que l'autre détermine s'il y a des boîtes sur la chaîne de transmission. Ce dernier perfectionnement a été introduit afin d'empêcher que la tête d'éjection ne fonctionne inutilement lorsque la chaîne est complètement dégarnie de boîtes en raison, par exemple, de l'espacement ou d'une panne de production.

Si l'on veut répondre à tous les systèmes de production, il faut placer les deux sondes de détection l'une au dessus de l'autre. En cas d'emploi de systèmes à courroies de transmission, la sonde inférieure (tête de sondage de carton) doit être insérée à l'intérieur de la ligne de débit de façon à ce que les articles soient pressés contre la surface.

Le détecteur BE 251 peut détecter une gamme variée de produits liquides ou solides, en poudre ou en pâte. Aliments, médicaments, poudres détergentes, boulettes de métal, etc. peuvent tous être vérifiés avant ou après la fermeture du carton.

Il arrive parfois que certains articles ne peuvent être détectés par aucune autre méthode. Celà est vrai, par exemple, des cartons contenant des films, qui ne pourraient être examinés par une méthode nucléaire car celà causerait le voilement du film. Seule la méthode capacitive peut être employée en ce cas, pour s'assurer si un carton est plein ou vide. Enfin, le BE251 peut, en certains cas, être employé pour déterminer si des cartons sont correctement remplis à un niveau fixé d'avance.

EE 8754 *pour plus amples renseignements*

CATHODEON CRYSTALS LTD (7)

Linton, Cambridgeshire

FOUR À CRISTAL MINIATURE

(Illustration à la page 237)

Spécialement étudié pour le contrôle précis de température des cristaux du type 2M, le four à cristal miniature CATHODEON convient particulièrement aux systèmes radiotéléphoniques mobiles à voies serrées où l'espace est fort restreint mais dont le contrôle de fréquence précis est, néanmoins, essentiel. Une stabilité de fréquence supérieure à ±0005%, dans une gamme étendue de températures, peut être obtenue aisément. Le four se distingue, en outre, par son encombrement réduit, sa consommation électrique minime et son chauffage rapide.

Prévu pour une alimentation de 6 ou 12 volts, l'appareil a une consommation électrique de 4,6 watts et il peut être réglé pour des températures de 75°C, 80°C et 85°C. La durée de chauffage est de moins de 5 minutes entre +20°C et +85°C. Enfin, il ne pèse que 43kg.

EE 8755 *pour plus amples renseignements*

CRISTAUX SUBMINIATURE

Un nouveau type de cristaux subminiature à prises vient d'être lancé sous la référence 2MM. Ces éléments sont particulièrement indiqués pour l'emploi avec les transistors et autres composantes miniature. Ils sont prévus pour une gamme de fréquences entre 5 et 75 MHz (de 5 MHz fondamentaux à 20 MHz et de 15 MHz résonance série à 75 MHz), avec un rendement de ±0,005%, de −55°C à 105°C.

EE 8756 *pour plus amples renseignements*

DAWE INSTRUMENTS LTD (66)

99 Uxbridge Road, Ealing, London W.5

VOLTMÈTRE ÉLECTRONIQUE INDIQUANT LA VALEUR EFFICACE RÉELLE

(Illustration à la page 237)

Au contraire des voltmètres électroniques courants, qui sont des instruments de lecture des valeurs moyennes et de crête, étalonnés pour la lecture des valeurs efficaces, le Voltmètre Type 612 mesure avec précision la valeur efficace réelle des formes d'ondes non sinusoïdales. Il permet donc d'obtenir des indications sûres de la valeur efficace de tensions ou de courants se rapportant à des dispositifs ou à des circuits non-linéaires. Treize gammes de tensions sont prévues avec des déviations totales de 300 μV, 1 mV, 3 mV, 100 mV, 300 mV, 1 V, 3 V, 10 V, 30 V, 100 V et 300 V. La réponse en fréquence est de ±3% entre 15 Hz et 150 kHz, et de ±5% entre 5 Hz et 500 kHz.

EE 8757 *pour plus amples renseignements*

OSCILLATEUR B.F. DE GRANDE PUISSANCE

(Illustration à la page 237)

Cet oscillateur est du type résistance-capacité accordée et sa gamme de fréquences s'étend de 20 Hz à 20 kHz. Il se caractérise par sa grande puissance de sortie (6 watts), s'accordant avec une impédance de charge de 15 ohms ou de 60 ohms, et lui permettant d'assurer directement le fonctionnement de haut-parleurs ou de petits générateurs de vibrations. Sa précision est de ±1% dans la gamme de 200 Hz à 20 kHz. Dans les autres gammes, elle est de ±2%.

EE 8758 *pour plus amples renseignements*

ELECTROTHERMAL ENGINEERING LTD (135)

270 Neville Road, London E.7

EQUIPEMENT POUR BRASAGE DE PRÉCISION

(Illustration à la page 237)

Cet équipement constitue un ensemble portatif compact et d'un fonctionnement aisé, destiné à l'emploi avec des alliages de brasage à base d'argent. Il est particulièrement utile pour le brasage des fils de résistances, en nickel-chrome ou en alliages analogues, c'est à dire lorsque la soudure tendre est difficile à utiliser ou lorsqu'elle a un point de fusion trop bas pour la tâche envisagée ou, encore, lorsque la soudure par points donne une couture trop faible.

Quoique prévu principalement pour le travail de précision (diamètre à partir de 0,025 mm), cet équipement peut également souder des fils atteignant jusqu'à 3,25 mm d'épaisseur.

La consommation de courant de l'équipement dépend du réglage de contrôle. Le maximum est d'environ 500 watts. La soudure est chauffée au moyen d'un élément usable mais pouvant, cependant, être facilement remplacé. Des récipients à flux décapants et à solutions pour enlever ces derniers sont fixés de façon commode pour l'opérateur, les solutions étant, bien entendu, chauffées. L'alimentation de l'équipment est prévue pour secteur alternatif, de 200 à 250 volts, sans réglage, ainsi que pour d'autres tensions alternatives sur commande spéciale.

EE 8759 *pour plus amples renseignements*

FORTIPHONE LTD (152)

92 Middlesex Street, London E.1

POTENTIOMÈTRES SUBMINIATURE

Le Potentiomètre subminiature type VS32 à interrupteur unipolaire est de dimensions extrêmement réduites et il a été réalisé à l'usage des amplificateurs pour sourds (appareils auditifs). Conçu pour être fixe frontalement ou de côté, il est tenu par une vis et un écrou. Son

diamètre total est de 8 mm et sa largeur est de 3,8 mm. Ses valeurs ohmiques vont de 1 kilohm à 2 mégohms et sa puissance nominale est de 50 mW.

Le Potentiomètre préréglé type PSR est destiné à l'emploi dans les circuits bobinés conventionnels ou dans les circuits imprimés. Son diamètre total est de 11,4 mm et sa largeur est de 2 mm. Les valeurs ohmiques et la puissance nominale sont identiques à celles du type VS32.

Le type PSS est un potentiomètre glissant préréglé de lignes et de construction simples dont la longueur totale est de 28 mm et la largeur totale de 7,2 mm. Sa gamme ohmique va de 1 kilohm à 3 mégohms et sa puissance nominale est de 50 mW.

EE 8760 *pour plus amples renseignements*

GEO. L. SCOTT & CO. LTD (133)

Cromwell Road, Ellesmere Port, Cheshire

NOYAUX ET TÔLES DÉCOUPÉES POUR TRANSFORMATEURS

Cette société vient d'ajouter à sa production, une nouvelle gamme de tôles subminiature pour transformateurs dont les dimensions hors-tout vont de 23 mm × 19 mm à 9,5 mm × 9,5 mm. Ces tôles sont destinées à l'usage des circuits de transistors, où l'espace est fort restreint.

Cette production comprend également des noyaux toroïdaux à base de fer-nickel, réalisés par traitement du fer en poudre. Ces noyaux sont fournis dans les normes RCL 193, sur bobines céramique pour hautes températures, pouvant recevoir directement les enroulements. Les caractéristiques constantes et le grand rendement qu'assurent ces alliages se vérifient lorsqu'on a besoin, par exemple, de paires accordées pour des amplificateurs magnétiques. Des noyaux toroïdaux à base de matériaux de fer au silicium, de 3,33 mm, 0,1 mm ou 0,05 mm d'épaisseur, peuvent également être fournis dans les normes RCL 193 ou dans celles des clients, pour des sources de puissance de basse et haute fréquence.

Enfin, des bandes à commutation rapide et grande perméabilité, dont l'épaisseur peut se réduire à 0,008 mm, sont produites sur bobines céramique pour matrices de rupture et autres dispositifs magnétiques de grand rendement.

EE 8761 *pour plus amples renseignements*

HINCHLEY ENGINEERING CO. LTD (91)

Pans Lane, Devizes, Wiltshire

TRANSFORMATEURS D'ISOLEMENT

(Illustration à la page 238)

En plus d'une gamme variée de transformateurs pour appareils de radio et de télévision, cette société exposera également un choix classique de transformateurs d'isolement et d'auto-transformateurs pour laboratoires, ateliers et services de dépannage. Ces transformateurs sont tous munis de sélecteurs de tension de sortie à fusibles rapidement remplaçables, et peuvent être fournis sur demande avec des bornes Mycalex à action instantanée.

Deux versions de la "boîte de sûreté" Hinchley constituent des éléments d'un intérêt spécial en raison du nombre croissant d'appareils électroménagers employés dans les ateliers et les jardins. Ce sont des transformateurs d'isolement portatifs, renfermés dans de robustes coffrets d'acier (le rapport d'isolement est de 1:1 ou, de préférence, une sortie de 110 V ou 55 V avec point central à la terre).

Ces transformateurs ont été spécialement étudiés pour la production en grosses quantités, de sorte que le coût final au consommateur fera de la sécurité une nécessité plus économique.

EE 8762 *pour plus amples renseignements*

JAMES A. JOBLING & CO. LTD (158)

Wear Glass Works, Sunderland

RÉSISTANCES À L'OXYDE MÉTALLIQUE

Ces résistances de haute précision et de grande stabilité sont faites de barres "Pyrex", revêtues d'une couche mince d'oxyde métallique. Le noyau et la couche d'oxyde métallique gardent toute leur imperméabilité et leur stabilité dans les conditions les plus défavorables et leur niveau de bruit est extrêmement bas.

La tolérance normale de ces résistances est de 1% et elles sont fabriquées sur commande, de façon à répondre aux besoins précis du client plutôt qu'à certaines préférences générales, dans les gammes de 100 ohms à 250 kilohms et pour une puissance de 0,5 watts à 2 watts.

EE 8763 *pour plus amples renseignements*

LABGEAR LTD (110)

Willow Place, Cambridge

CONTRÔLEUR D'ISOLEMENT NON-DESTRUCTIF

(Illustration à la page 238)

Cet appareil a été conçu pour les essais d'isolement de circuits et de composantes tels que les condensateurs faibles.

Le modèle standard assure des tensions de contrôle en alternatif de 250 V, 500 V, 11 kV, 1,5 kV et 2 kV. Une des caractéristiques de l'appareil est qu'il permet de contrôler une composante fonctionnant à une tension supérieure à sa tension de service normale. En cas de panne, la composante n'est nullement endommagée et peut être utilisée à nouveau à un potentiel plus faible. Le contrôle de composantes et d'accessoires peut donc être effectué sans risque d'endommagement.

EE 8764 *pour plus amples renseignements*

LUSTRAPHONE LTD (111)

St. George's Works, Regents Park Road, N.W.1

MICROPHONE STÉRÉOPHONIQUE

(Illustration à la page 238)

Cet appareil microphonique se compose de deux microphones à rubans identiques, montés en ligne verticalement. La partie supérieure de l'élément, qui contient l'un des microphones, est construite de manière à pouvoir être tournée continûment sur un angle de 100° environ, à partir de la position "en ligne," permettant ainsi d'obtenir le meilleur réglage dans n'importe quelle éventualité (de transmission stéréophonique, enregistrement, radiodiffusion, renforcement du son, etc.). La partie inférieure est montée de manière fixe.

L'appareil est relié à un élément de commutation au moyen d'un connecteur à vis à quatre directions. L'avantage de cette méthode est qu'elle permet de détacher instantanément la tête sensible du microphone et de la ranger en lieu sûr, sans, toutefois, déranger le montage et les connexions vers l'installation principale.

Un interrupteur de conception spéciale est prévu pour trois positions, à savoir:

1. Position "arrêt" au centre.
2. Branchement stéréophonique à l'extrémité d'un des côtés.
3. Position à l'autre extrémité de l'interrupteur, reliant en série les deux éléments à rubans et changeant ainsi l'appareil en un microphone à ruban de vitesse de haute sensibilité et à caractéristique polaire "8".

Un interrupteur déphaseur, fixé à l'arrière de l'élément de commutation, permet l'inversion de phase instantanée, de manière à assurer la phase voulue sur n'importe quel équipement.

Lorsque le Microphone Stéréophonique est à la susdite position 3, et que les deux éléments sont "en ligne," on peut le changer, au moyen de l'interrupteur déphaseur, en un microphone éliminateur de bruit fort efficace, ne répondant à une source de bruit qu'à une distance rapprochée.

Conjointement avec les positions alternatives de l'interrupteur déphaseur, on obtient, par le positionnement intermédiaire correspondant des éléments microphoniques, divers effets directionnels fort utiles dans des conditions acoustiques défavorables.

L'impédance de chacun des éléments microphoniques dans le modèle standard est de 20 ohms et l'impédance totale de l'appareil composé, branché sur la position de série, est de 40 ohms.

EE 8765 *pour plus amples renseignements*

MC MURDO INSTRUMENT CO. LTD (32)

Victoria Works, Ashtead, Surrey

SUPPORTS DE LAMPE ET CONNECTEURS

Une nouvelle gamme de supports de lampes "petite plume," à moulage vierge simple du type B9A ou B7G, pour cir-

cuits imprimés et câblages classiques, est présenté par cette société.

Le moulage est conçu pour recevoir une griffe à ressort ordinaire, faisant partie intégrante de la monture métallique du support de lampe. En outre, les lampes peuvent être blindées au moyen d'écrans métalliques peu coûteux, épousant étroitement l'enveloppe de la lampe. Ces écrans sont tenus et mis à la terre électriquement par la griffe à ressort.

La gamme des fiches et douilles PAKONECTOR a été augmentée par la réalisation d'un modèle à 8 directions, de la même grandeur à peu près que le support de lampe B7G. On trouve les mêmes avantages de raccordement de câbles dans le modèle à 8 directions que dans les versions originales à 18 directions.

EE 8766 *pour plus amples renseignements*

MULLARD LTD (77/67)

Mullard House, Torrington Place, London W.C.1

TUBES À RAYONS CATHODIQUES DE 110°

Des tubes cathodiques de 110° à écrans de 534 mm et 432 mm sont produits par cette société sous les références de modèles AW53-88 et AW43-88 respectivement.

Ces nouveaux tubes sont sensiblement plus courts que les tubes de diamètre égal d'usage courant et ils permettent donc de réduire la profondeur des récepteurs de télévision.

Le tube de 110° à écran de 534 mm est plus court de 216 mm que le tube de même écran de 70°, et plus court de 127 mm que celui de 90°. Quant au tube de 110° à écran de 432 mm, il est plus court de 165 mm et de 76 mm que les tubes à écrans équivalents de 70° et 90° respectivement.

La substance luminescente de grande efficacité des nouveaux tubes est à fond métallique, assurant ainsi une brillance et un contraste parfaits dans les conditions de forte lumière ambiante. Leur focalisation est électrostatique et ils comportent un canon à électrons du type "droit", ce qui rend superflu l'aimant piège à ions.

EE 8767 *pour plus amples renseignements*

PAINTON & CO. LTD (29)

Kingsthorpe, Northampton

RÉSISTANCES MINIATURE À HAUTE STABILITÉ

Ces résistances au charbon à haute stabilité, du type 70, sont de dimensions extrêmement réduites, ne mesurant, à peu près, que 9,5 mm × 2.5 mm. Elles sont donc indiquées pour l'emploi dans des équipements transistorisés miniature et, en particulier, pour les plaques a circuits imprimés. Les conducteurs sont préétamés afin de faciliter leur brasage par immersion. La gamme de résistances s'étend à toutes les valeurs standard, de 5 à 250 kΩ, avec une tolérance de 5%, mais des tolérances de 1 et de 2% peuvent, si nécessaire, être prévues sur presque toute la gamme.

EE 8768 *pour plus amples renseignements*

CONNECTEURS DE CIRCUITS IMPRIMÉS

(Illustration à la page 239)

Un nombre de connecteurs de circuits imprimés vient d'être mis sur le marché. Il comprend une fiche à 15 directions et une prise à goujons d'acier. De même que tous les connecteurs PAINTON pour circuits imprimés, les contacts sont sur module de 2.54 mm.

La production Painton comporte également un connecteur coudé comprenant jusqu'à 60 contacts, en trois groupes de 20 avec centres de 2.54 mm. Ces contacts sont d'un modèle spécial breveté et les essais ont démontré qu'ils permettent une insertion sur plaque de très longue durée.

EE 8769 *pour plus amples renseignements*

SUPPORTS DE LAMPES À ANGLE DROIT

(Illustration à la page 239)

Ces composantes ont été développées afin de permettre le montage horizontal des lampes, facilitant ainsi la production d'assemblages de circuits imprimés plus compacts et simplifiant le dispositif de source froide.

Les contacts sont en cuivre au glucinium argenté et leur longueur est telle qu'elle s'adapte aux épaisseurs de circuits imprimés les plus communément employées. Les pressions correctes d'insertion et de retrait sont maintenues avec le minimum de résistance de contact.

EE 8770 *pour plus amples renseignements*

STEATITE AND PORCELAIN PRODUCTS LTD (76)

Stourport-on-Severn, Worcestershire

JOINTS À BORNES

(Illustration à la page 239)

Selon l'annonce préliminaire de l'année dernière, la nouvelle gamme de joints à bornes se conforme à la Spécification militaire RCL 331. Ces joints sont en céramique à base étendue d'alumine et les tiges sont fermement fixées en place par fusion. Des bandes métallisées extérieures, réalisées par le procédé de métallisation de nickel de qualité agréée, sont fournies conjointement. Elles permettent le brasage tendre direct dans les enveloppes métalliques pour toutes les applications de fermeture hermétique.

Les gammes standard de joints métallisés au nickel de la qualité agréée dans la catégorie H1, sont toujours livrables du stock et un service spécial chargé de la fabrication d'échantillons fournit, sur court préavis, des prototypes de nouveaux modèles. D'autre part, on a considérablement développé les services d'assemblage des produits en céramique métallisée, avec des ferrures appropriées, afin de répondre à une variété étendue d'applications allant des cosses miniature aux grandes bornes haute tension des condensateurs.

EE 8771 *pour plus amples renseignements*

SWIFT LEVICK & SONS LTD (156)

Clarence Steel Works, Sheffield 4

GRANDE AIMANTS PERMANENTS

(Illustration à la page 240)

Cette société vient d'ajouter à sa production les grands aimants stables à haute homogénéité pour les applications de résonance magnétique nucléaire. Notre gravure montre un de ces aimants, qui a été étudié et produit pour les travaux de recherches de l'Université de Leeds. Cet aimant pèse 2350 kg. et son encombrement est de 1,21 m × 1,07 m × 0,61 m. Il est excité de façon permanente par l'alliage Columax, qui constitue la matière pour aimants la plus stable et la plus puissante qui puisse être produite commercialement en n'importe quelle partie du monde. L'aimant a une puissance du champ d'entrefer de 9700 Oersteds sur un volume d'entrefer de 36 mm de long × 254 mm de diamètre. L'uniformité du champ est supérieure à 1 partie dans 10^6 sur un volume central d'environ 1 cm^3. L'une des pièces polaires en fer est pourvue d'un dispositif d'ajustement mécanique spécial, permettant un mouvement réduit de la face polaire sur n'importe quel plan afin de pouvoir effectuer un réglage final uniforme de la puissance du champ d'entrefer.

Un modèle d'un sixième de la grandeur de cet électroaimant sera exposé au Salon.

EE 8772 *pour plus amples renseignements*

TELEPHONE MANUFACTURING CO. LTD (21)

Hollingsworth Works, London S.E.21

RELAIS MULTIPLE

(Illustration à la page 240)

Le nouveau relais multiple à 10 directions TMC sera exposé au Salon. De nombreux procédés entièrement nouveaux ont été utilisés dans sa fabrication, dont le résultat a été d'en réduire le prix en augmentant son efficacité. Le relais multiple TMC emploie une culasse commune faisant partie intégrante des supports de fixation et il est destiné à remplacer les relais de type téléphonique dans les circuits de contrôle où le coût des éléments joue un rôle primordial.

Les ressorts de contact en bronze phosphoreux, avec contacts bimétalliques d'argent, selon la technique dite des rayons croisés, ainsi que la réglage mécanique automatique et le fonctionnement, assurent une pression de contact constante qu'on ne trouvait jusqu'ici que sur les relais coûteux de précision. Un circuit magnétique efficace empêche virtuellement toute interaction magnétique entre les relais, tandis que les supports de fixation à culasse commune réduisent grandement le nombre des pièces et rendent inutiles les supports séparés.

Le prix de ce relais multiple est tel qu'on constatera souvent qu'il est plus économique d'installer un élément à 10 directions qu'un moindre nombre de relais conventionnels.

EE 8773 *pour plus amples renseignements*

The advertisement pages *in this section are available for British and Overseas advertisers to present their products to electronics engineers all over the world. They will command much attention.*

For further details write to THE ADVERTISEMENT MANAGER

Les pages d'annonces *de cette section sont réservées à la publicité des sociétés britanniques et étrangères afin de leur permettre de présenter leurs fabrications aux ingénieurs-électriciens du monde entier. Elles attireront une attention considérable.*

Pour plus amples renseignements s'adresser au CHEF DE LA PUBLICITÉ

Die Anzeigenseiten *in diesem Teil stehen britischen, europäischen und überseeischen Inserenten zur Einführung ihrer Erzeugnisse bei elektronischen Ingenieuren auf der ganzen Welt zur Verfügung. Sie werden immer gebührende Aufmerksamkeit auf sich ziehen.*

Wegen weiterer Einzelheiten wenden Sie sich bitte AN DEN WERBUNGSLEITER

Electronic Engineering

28 ESSEX ST., STRAND, LONDON, W.C.2, ENGLAND

Telephone: CENtral 6565 *Telegrams: 'Lectroning, Estrand, London'*

EE 8109 *for further details*

SOLARTRON

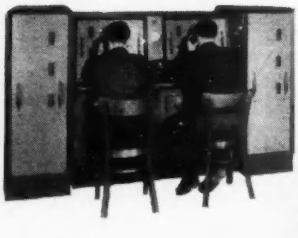
FABRIQUE LES MEILLEURES INSTALLATIONS ÉLECTRONIQUES!

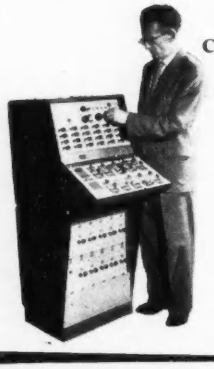
Le Groupe Electronique SOLARTRON — au nombre des principaux fabricants d'installations électroniques en Europe — vous offre, dans votre propre pays, son assistance technique et ses conseils experts en ce qui concerne tous les aspects de l'emploi d'instruments électroniques.

Les instruments électroniques de précision "Solartron" sont employés dans le monde entier et leur champ d'application s'étend toujours plus: mesures absolues, relatives et vectorielles; analyse visuelle et indication (par oscilloscope); estimation rapide de servo-éléments et de systèmes dynamiques; contrôle de réseaux de communications. Toutes ces performances, ainsi que de nombreuses autres dans le domaine des recherches et du contrôle de production sont effectuées journellement grâce aux instruments de précision "Solartron".
Une nouvelle gamme d'appareils "SPACE" pour calculation analogue a été introduite récemment, alors que d'autres installations d'importance majeure dans leur propre domaine d'application comprennent ERA (Solartron Electronic Reading Automaton); systèmes de simulation pour radar; "SAKI", machine pour l'instruction d'opérateurs de machines à cartes perforées; ainsi que des installations de contrôle industriel, comme le Spectromètre automatique à rayons X fluorescents et le dispositif électronique de contrôle ultra-rapide de pesage. D'autre part, une gamme complète de sources d'énergie stabilisées pour le développement de circuits du type classique ou du type à transistor.
L'excellente réputation que la gamme complète d'instruments électroniques "Solartron" s'est acquise du point de vue de la stabilité de performance, de la précision des mesures et de l'indication, ainsi que de la sûreté de fonctionnement — même dans des conditions d'emploi les plus sévères — a été obtenue grâce à l'adoption de normes de fabrication de haute précision aussi bien dans le domaine électrique que mécanique.
Le degré d'efficacité optimum des instruments "Solartron" se reflète dans le fait qu'ils ont reçu la distinction "Joint Service Approval" — certificat délivré par le Gouvernement pour l'emploi de ces instruments, en campagne, par les Forces Armées Britanniques.

Systèmes "Solartron" de Simulation pour Radar

Ensembles typiques d'un système de simulation d'objectifs multiples tels qu'actuellement employés par l'organisation de défense NATO. Ce système peut être intégré dans toute installation de radar.



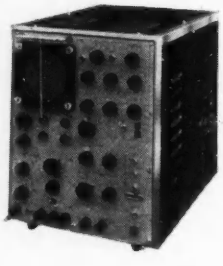


Calculateur analogue "Solartron" MINISPACE TY864

—pour la solution rapide de problèmes compliqués de dynamique, la réduction de données, la simulation de systèmes de contrôle, etc . . .

Sous-ensemble de source d'énergie stabilisée AS850

—un sous-ensemble typique d'énergie, sans impédance, de la gamme "Solartron" comprenant 30 sources d'énergie. Des versions avec transistor peuvent également être fournies.



SOLARSCOPE CD643.2 (CT380)

—l'oscilloscope de mesure le plus précis actuellement en production et permettant des mesures précises sur axes "X" et "Y".

Ne tardez pas à contacter l'organisation "Solartron" en ce qui concerne l'assistance compétente et experte qu'elle est à même de vous offrir dans le domaine des développements les plus récents en électronique.

THE SOLARTRON ELECTRONIC GROUP LTD

c/o Société Française de Cadrans, 133 Boulevard de Charonne, PARIS (XIème). Téléphone: Voltaire 7090

THE SOLARTRON ELECTRONIC GROUP LTD

THAMES DITTON · SURREY · ANGLETERRE
Téléphone: EMBerbrook 5522 — Télex international: 23842 Solartron T. Dit.
Câbles: Solartron Thames Ditton.

WHITELEY ELECTRICAL RADIO CO. LTD (81)

Radio Works, Victoria Street, Mansfield, Nottinghamshire

CONTRÔLEUR DE CABLES

(Illustration à la page 240)

Cet appareil de contrôle localise, à quelques millimètres près, l'endroit d'une coupure ou d'un court-circuit dans les câbles armés à plusieurs conducteurs. Ces derniers peuvent être, ensuite, réparés avec un minimum de dérangement de l'armure.

Le principe de fonctionnement est comme suit:

En cas de conducteur brisé, une tension de fréquence acoustique est appliquée entre l'une des extrémités du conducteur et la terre. Le champ électrostatique entre la partie sous tension du conducteur et la terre peut être, ensuite, détecté en faisant passer une sonde capacitive le long du câble. La sonde est reliée à l'entrée d'un amplificateur à transistors portatif qui alimente un casque d'écoute, donnant ainsi une indication audible de l'endroit de la rupture. Tous les autres conducteurs, à l'exception de celui que l'on contrôle, doivent être mis à la terre.

Lorsqu'on veut repérer un court-circuit entre des conducteurs, on emploie une sonde inductive au lieu d'une sonde capacitive. L'oscillateur ne transmettra un signal au conducteur que jusqu'au point précis où le court-circuit se produit et la sonde détectera le champ magnétique jusqu'à ce point.

Le tableau de contrôle est muni de commutateurs rotatifs pouvant choisir des conducteurs particuliers à l'intérieur du câble. Les conducteurs autres que celui qui a été choisi sont mis à la terre. Des prises sont pourvues pour recevoir les fiches des câbles. Un ohmmètre du type à lampe est fourni pour pouvoir s'assurer au préalable de l'état d'un conducteur.

L'oscillateur à lampe fonctionne sur pile; il a une puissance de sortie de 10 mW et une impédance de sortie de 300 ohms. Sa fréquence est de 1 kHz à ±2,5%. Le type d'oscillation peut être soit continu soit interrompu, selon le réglage du potentiomètre.

L'amplificateur à transistors fonctionne sur pile de 4,5 volts renfermée dans le boîtier et il a un gain total de 70 décibels lorsqu'il est relié à une charge non inductive de 300 ohms. La sonde inductive est accordée à kHz ±2,5%.

EE 8774 *pour plus amples renseignements*

THE ZENITH ELECTRIC CO. LTD (8)

Zenith Works, Villiers Road, Willesden Green, N.W.2

TRANSFORMATEUR RÉGULATEUR

(Illustration à la page 240)

Un nouveau modèle de transformateur, le "VARIAC 50-B/2B", à double sortie, sera exposé au Salon cette année. Il a été étudié en vue d'une alimentation de 230 volts, 50 Hz, assurant une puissance de sortie variant entre 0 et 270 volts et une intensité nominale maximum de 20 A, ce qui constitue le courant total pouvant être tiré des deux balais, mais la charge peut être, évidemment, répartie de manière à pouvoir répondre, par exemple, à une application exigeant 12 A —Sortie Uo. 1 et 8 A—Sortie No. 2.

Les transformateurs VARIAC à deux balais et à double sortie existent depuis longtemps déjà dans la série "100" et "V30H", ainsi qu'en format réduit dans la gamme toroïdale de la série "200".

Le modèle réduit a maintenant été modifié en employant certaines pièces de la série "V5", ce qui a donné un élément bien plus compact.

EE 8775 *pour plus amples renseignements*

CONTRÔLEUR DE CIRCUITS DE RETOUR PAR LA TERRE

Cet appareil est logé dans un meuble métallique muni d'une manette de support et d'une pochette pour câble d'entrée et fiche. Il a été étudié en vue de pouvoir exécuter intégralement tous les essais exigés par le Règlement No. 507 de l'INSTITUTE OF ELECTRICAL ENGINEERS, ainsi que pour fonctionner sur courant monophasé ordinaire d'une puissance de sortie de 25 A, à n'importe quelle tension entre 0 et 40 volts.

Un transformateur abaisseur bifilaire ZENITH est employé avec un VARIAC à travers le primaire et un voltmètre de redresseur est fourni, de même qu'un ampèremètre. En outre, une prise de courant à trois broches de 13 A, ainsi qu'une prise à trois broches de 15 A, se trouvent à l'avant du coffret pour le contrôle du noyau de mise à la terre des appareils portatifs. La tension de 40 volts est prévue pour la plupart des essais mais celle de 6 volts est également comprise car elle convient mieux éventuellement aux petits circuits bouclés comme ceux des outils portatifs ou autre matériels d'outillage analogues.

Enfin, un coupleur est prévu pour le contrôle d'appareils fixes, pour lequel la tension de 6 volts est employée, car le fil de masse est relativement court et ne dépasse pas 0,1 ohm, ce qui représente environ 3 volts.

EE 8776 *pour plus amples renseignements*

ERRATA :

Nous nous excusons auprès de nos lecteurs des erreurs qui se sont glissées dans les indications des vitesses d'avance de la bande de l'Enregistreur à bande magnétique pour calculateurs électroniques, construit par la Société Epsylon Industries Limited, dans la description que nous en avons donné à la page 193 de notre numéro de mars 1959. Ces vitesses sont en réalité comme suit:

Vitesse actuelle de la bande: 254 cm/sec.
Vitesse future de la bande: 508 cm/sec.
Vitesse de bobinage accéléré: 1016 cm/sec.

Résumés des Principaux Articles

Potentiomètres linéaires à plusieurs prises et à sorties chargées par K. C. Garner

Résumé de l'article aux pages 192 à 199

L'auteur analyse les potentiomètres linéaires à plusieurs prises, du type à résistances de shunt reliées entre prises intermédiaires adjacentes faisant face à une résistance de charge de sortie.

En utilisant le rapport d'un réseau généralisé avec des substitutions numériques appropriées, obtenues d'un dispositif à potentiomètres dont l'auteur traite en particulier, l'évaluation devient un procédé simple et systématique.

L'auteur propose en conclusion une méthode pour la fabrication de potentiomètres produisant des fonctions non-linéaires.

L'analyse des bruits de chocs par F. M. Savage

Résumé de l'article aux pages 200 à 203

Les instruments pour la mesure et l'analyse de bruits persistants ont permis d'établir des critères de recherches en vue de prévenir la surdité chez les personnes exposées à des bruits continus. Le perfectionnement des analyseurs de bruits de chocs devraient fournir des données pour l'étude de la

réduction des bruits de chocs les plus dangereux pour l'ouïe. Cet article décrit un petit appareil portatif pour la mesure de bruits d'impacts. Cet appareil peut également servir à d'autres usages, tels que la mesure d'accélérations de pointe, lorsqu'on l'utilise avec un accéléromètre adéquat.

Amplificateur à transistors pour le réenregistrement de bandes magnétiques et rouleaux. par A. E. Bachmann.

Résumé de l'article aux pages 213 à 217

On emploie fréquemment les bandes magnétiques et les rouleaux comme éléments enregistreurs ou émetteurs contenant les données sous forme numérale. Ces renseignements peuvent être obtenus à nouveau en réenregistrant la bande ou le rouleau voulu au moyen d'une tête magnétique et d'un amplificateur. Cet article examine les problèmes que pose la réalisation d'un pareil amplificateur en n'employant que des transistors. Il décrit, en particulier, un prototype d'amplificateur dont on vient d'effectuer les essais et qui fonctionne à partir d'une tête de réenregistreemnt dont la tension de sortie à circuit ouvert dépasse 2 mV. Cet amplificateur est capable d'actionner en parallèle trois multivibrateurs bistables dans une gamme de fréquences de 2 à 400 kHz. et une gamme de températures de 0°C à + 70°C. La durée de montée de l'impulsion de sortie est de moins d'une microseconde.

Un oscillateur simple de très basse fréquence par J. F. Young

Résumé de l'article aux pages 218 à 220

Les méthodes usuelles de stabilisation d'amplitude d'oscillateurs résistance-capacité sont des méthodes sensibles aux fréquences. Dans l'oscillateur simple décrit dans cet article, une diode Zéner limite l'amplitude, de sorte que les harmoniques qui en résultent sont filtrés par un circuit sélectif, qui contrôle également la fréquence des oscillations. On peut donc obtenir une forme d'onde tolérable, même à de très basses fréquences.

Une méthode stroboscopique pour effectuer des mesures de réponse de fréquence sur des petits dispositifs électromécaniques par M. Shepherdson et R. Walters

Résumé de l'article aux pages 220 à 221

Cet article décrit une méthode permettant d'effectuer des mesures de réponse de fréquence sur des petits dispositifs électromécaniques utilisant un microscope mobile et une lampe stroboscopique. En dehors d'un simple amplificateur d'impulsions et d'un réseau de déphasage que les auteurs décrivent, l'attirail nécessaire à cette méthode se trouve généralement dans la plupart des laboratoires électriques bien outillés. La méthode n'implique pas le chargement de l'accessoire d'essai et permet d'effectuer des mesures d'amplitude bien au dessous de 0,025 mm.

Alimentation stabilisée par D. J. Collins et J. E. Smith

Résumé de l'article aux pages 222 à 226

L'alimentation accordée ou stabilisée en courant continu est nécessaire à divers usages. Le sauteurs examinent succinctement les différents types de régulateurs, décrivant, ensuite, plus en détail, le stabilisateur de circuit bouclé. Les problèmes de fabrication que pose ce genre de dispositif, sont également étudiés, tout particulièrement en ce qui concerne la stabilité du circuit fermé. Un dessin détaillé d'un stabilisateur-type figure à l'appendice.

La télémesure par l'application du principe du tube répartiteur à gaz par Yoshisuke Hatta

Résumé de l'article aux pages 227 à 229

L'auteur décrit une méthode de télémesure du déplacement mécanique par l'application du principe du tube répartiteur à gaz. Ce tube étant un élément électronique, il a un bon fonctionnement à action rapide et il est, donc, supérieur, à certains égards, aux systèmes électromagnétiques dont l'inertie est considérable.

Condensateurs au tantale à électrolyte solide. par R. Aries.

Résumé de l'article aux pages 230 à 231

Les condensateurs au tantale à électrolyte solide sont communément utilisés dans les appareils miniature. Cet article décrit brièvement leur procédé de fabrication ainsi que les résultats d'essais de durée et de propriétés thermiques.

Die Ausstellung BRITISCHE BAUELEMENTE FÜR DIE ELEKTRONIK

Beschreibungen, zusammengestellt auf Grund von Mitteilungen aus Herstellerkreisen, einer Auswahl von Geraten, die auf der Ausstellung des Verbands der Hersteller von Bauelementen für die Radio-und Elektronik-industrie im Grosvenor House und Park Lane House, London, vom 6.-9. April zur Schau gelangen werden. (*Die in Klammern angegebenen Zahlen und Buchstaben beziehen sich auf die Standnummern*)

(*Übersetzung der Seiten 236 bis 240*)

AVO LTD (73)

Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1

SPULENWICKELMASCHINE

Eine neue Spulenwickelmaschine wird zur Ausstellung kommen, die in der Lage ist, beinahe vollkommen lagengewickelte Spulen ohne die Verwendung jeder Art von Verflechtungsvorrichtung zu wickeln. Die normale mechanische Kupplung zwischen Spindelstock und Traverse der Maschine wurde überflüssig gestaltet und beide werden durch unabhängige Motoren angetrieben, deren betreffende Drehzahlen mittels eines Sondenkopfs gesteuert werden, der den Drahtvorschubswinkel überwacht um zu gewährleisten, dass jede einzelne Windung sich genau, sofern praktisch möglich, an die vorhergehende anlegt. Der beträchtlich verbesserte Raumfaktor von mittels dieser Maschine hergestellten Spulen gewährleistet ein Höchstmass elektromagnetischer Leistung-ein Faktor der von besonderer Wichtigkeit für solche Bauelemente wie Relais und Solenoiden ist, insbesondere für Miniaturtypen, während die weitaus genauere rechteckige Profilierung von auf diese Weise gewickelten Spulen viele Möglichkeiten für die Verwendung von selbsttragenden Spulen eröffnet, wo früher Formvorrichtungen erforderlich waren.

EE 8751 *für weitere Einzelheiten*

BRAYHEAD (ASCOT) LTD (167, 169)

Full View Works, Kennel Ride, Ascot, Berks

FERNSEH-REVOLVERTUNER

(*Abbildungen auf Seite 236*)

Der Tuner PB. 1 ist ein Hochleistungs-10 Positionentuner von kompakter Konstruktion mit Vorrichtungen für Ein- und Mehrfachkanalbelastung, geschaltetem Feintuner-Bereich und Vorrichtung für Ein- oder Dreiposition—FM—Ton. Er bietet hohe Leistungsgüte in Bezug auf Verstärkung, Drift, Rauschen, Stabilität und Wiedergabeform.

Die Tuner PB. 3 und PB. 4 sind das Ergebnis der vereinten Bemühungen von Plessey und Brayhead. Sie besitzen dieselben kompakten Gesamtabmessungen wie der PB. 1, mit 14 Kanälen im PB. 3 und 18 Kanälen im PB. 4, wobei beide eine zusätzliche Position für den Zusatz einer UHF-Vorsatzvorrichtung freihalten.

Fernseh-FM-Schalten lässt sich entweder vermittels eines Flachschalters, der auf der rückwärtigen Spindelver längerung angebracht ist, oder mittels eines nockengesteuerten Gleitschalters vornehmen, wobei der letztere in für Ein- oder Mehrfachkanal-FM-Abstimmen geeigneten Ausführungen zur Verfügung steht.

Der Benützer hat eine Auswahl von vielen Zusatzvorrichtungen, die die Anwendungsmöglichkeiten sehr vielseitig gestalten; unter diesen befinden sich:—

Gedrucktes ZF-Filter, Ein- oder Mehrfachkanal-FM-Abstimmen, eingebaute Isolierungsbaulemente, Schmal- oder Breitband-Feintuner, verstellbare Antennenspulen, induktiv-gekoppelte Eingangs-Schaltung, ZF-Ausgangsschaltung mit doppelter Abstimmung, Ein-oder Doppelkanalbelastung, ZF-Ausgangsschaltung mit Doppelfrequenz, eingebautes Empfindlichkeitsschalten, eingebautes Antennenschalten. Vorkehrung für die Verwendung der PCC. 89 Röhre, oder 30L15/30C15 Kombination ist gleichfalls getroffen.

Zusätzlich zu normalem Kanalisieren für die Britischen Inseln können diese Tuner mit Kanälen für F.C.C. oder C.C.I.R. Systeme, oder für weitere in andern Ländern erreichbare Sonderkanäle versehen werden.

EE 8752 *für weitere Einzelheiten*

DEUTSCHE INDUSTRIE-MESSE HANNOVER

'Electronic Engineering' befindet sich auf Stand 2 in Halle 13 auf der Deutschen Industrie-Messe Hannover vom 26. April bis 13. Mai, und Besucher werden herzlich wilikommen geheissen.

BRITISH PHYSICAL LABORATORIES (88)

Houseboat Works, Radlett, Hertfordshire

UNIVERSALIMPEDANZBRÜCKE

(*Abbildungen auf Seite 236*)

Diese Universalimpedanzbrücke ist ein Allzweckgerät, mit einem weiten Messbereich von Widerstands-, Induktanz- und Kapazitanzwerten.

Bei Verwendung für Widerstandsmessung wird das Gerät als eine Wheatstone'sche Brücke mit einer internen Brückengleichspannungsspeisung angeschlossen. Um Eigenerwärmung zu verhindern, insbesondere bei Niederstrom-Kohlenstoffwiderständen wurde die Brückenspannung auf einen derartigen Wert reduziert, dass bei jeder beliebigen Messung die sich unter Prüfung befindliche Widerstandtslast einen Wert von 16 mW nicht übersteigt. Die unsymmetrische Spannung wird mittels eines Zerhackungsverstärkers verstärkt und die Anzeige gesschieht vermittels eines 102 mm Meters, der mit einer automatischen Überlastschutzvorrichtung ausgestattet ist.

Dank der Kombination eines kontinuierlich regelbaren Widerstands und eines Dekadenwiderstands wird eine ungewöhnlich grosse Skalenlänge, nämlich 18,3 m, erzielt. Diese Anornung wird zur Widerstands-, Kapazitanz- und Induktanzmessung verwendet, und ermöglicht eine erhöhte Genauigkeit.

Als Kapazitanzmessbrücke wird das Gerät in Form einer modifizierten de Saute-Brücke angeordnet und wird von einem internen Oszillator mit einer Brückenspannung von 1 kHz gespeist. Der dielektrische Verlust wird mit einer zweiten regelbaren Steuerung in Verbindung mit einem fünfgängigem Schalter gemessen. Vorkehrungen zum Anschluss einer externen Gleichstromquelle zum Anlegen einer überlagerten Gleichstromspannung an den sich unter Prüfung befindlichen Kondensator sind getroffen. Nullgleichrichtung wird mittels eines abgestimmten Verstärkerdetektors bewirkt, dem ein mit einer automatischen Überlastschutzvorricht-

ung ausgestatteter 102 mm Anzeiger nachgeschaltet ist.

Für die Messung von Induktanz wird das Gerät in eine Hay'sche Brücke umgewandelt, wobei der Reaktivstandard aus einem versilberten Mikakondensator besteht; Dieselben Steuerungen kommen zur Verwendung wie für Kapazitanz- und Kraftfaktorausgleich. Durch Anschliessen einer externen Gleichstromquelle kann ein Strom durch die siche unter Prüfung befindliche Spule geleitet werden.

EE 8753 *für weitere Einzelheiten*

BURNDEPT LTD (121)

Erith, Kent

KARTONINHALT-MONITOR

(Abbildungen auf Seite 237)

Der 'Burndept' Kartoninhalt-Monitor Typ B.E. 251 verwendet einen Annäherungsschalter, der bei hoher Geschwindigkeit den metallischen oder nichtmetallischen Inhalt Bestimmen kann, vorausgesetzt dass der kartonierte Gegenstand eine genügend grosse Veränderung des elektrischen kapazitiven Widerstands der Bestimmungssonde gegenüber aufweist.

Der Gerätesatz für den Kartoninhalt-Monitor umfasst:

(a) Einen Kartoninhalt-Monitor BE.251
(b) Einen Kartoninhalt-Monitor Auswerferkopf BE.257
(c) Zwei Kartoninhalt-Monitor Verbindungsstücke
(d) Einen Karton - Bestimmungskopf BE.258
(e) Einen Kartoninhalt-Bestimmungskopf BE.243

Die Posten (d), (e) und manchmal (b) müssen speziell konstruiert werden, um jeder betreffenden Anwendung gemäss der Grösse der zur Verwendung gelangenden Kartons zu entsprechen.

Der Auswerferkopf und die Bestimmungssonden werden in der Regel in der Nähe des Förderbands installiert, während die andern Einheiten im Innern eines gusseisernen Geräteschranks untergebracht sind, der an der nächststehenden Wand befestigt werden kann.

Grundsätzlich werden zwei Annäherungsschalter als Detektoren verwendet, während das Steuerungsaggregat ihre Leistung und das Betätigen des Auswerferkopfs koordiniert. Ein Annäherungsschalter bestimmt (über seine Bestimmungssonde) ob eine Schachtel voll oder leer ist, während der andere fesstellt, ob sich irgendwelche Schachteln auf dem Förderband befinden. Diese letztere Verfeinerung wurde einbegriffen, um etwaigen unnötigen Betrieb des Auswerferkopfs zu verhindern, im Falle sich überhaupt keine Schachteln auf dem Förderband befinden, wie z.B. durch Abstandseinteilung oder Fertigungsausfall.

Um vollständige Erfassung für alle Fertigungssysteme zu gewährleisten ist es erforderlich, die beiden Bestimmungssonden übereinander anzubringen. Wo Bandzubringsysteme zur Verwendung kommen, muss die untere Sonde (Kartonbestimmungssonde) innerhalb des Förderbands so eingebaut werden, dass die Gegenstände unter Druck über seine Oberfläche geführt werden.

Der Monitor BE.251 kann einen weiten Bereich von Erzeugnissen in fester, Pulver-, Pasten- oder flüssiger Form bestimmen. Nahrungsmittel, Drogen, Reinigungspulver, metallische Kügelchen usw. lassen sich alle sowohl vor als auch nach dem Verschliessen des Kartons prüfen. Manchmal lassen sich gewisse Gegenstände einfach nicht durch andere Methoden bestimmen, z.B. Kartons, in denen Filme verpackt sind, dürfen nicht vermittels einer Kernmethode untersucht werden, da sonst 'Bewölkung' des Films auftreten würde, und in diesem Fall darf lediglich die kapazitive Methode zur Anwendung kommen um zu bestimmen, ob ein Karton voll oder leur ist. In gewissen Fällen kann der BE.251 auch dazu verwendet werden zu bestimmen, ob die Kartons bis zu einer vorbestimmten Höhe richtig gefüllt.

EE 8754 *für weitere Einzelheiten*

CATHODEAN CRYSTALS LTD (7)

Linton, Cambridgeshire

MINIATUR-KRISTALLOFEN

(Abbildungen auf Seite 237)

Der speziell für genaue Temperaturregelung von Kristallen der Type 2M entworfene 'Cathodean' Miniatur-Kristallofen is besonders gut geeignet für fahrbare Nahkanal-Radiotelefonsysteme, wo Präzisions-Frequenzregelung unerlässlichist, die Platzfrage jedoch an erster Stelle steht. Frequenzstabilität, besser als ±0·0005% innerhalb eines grossen Temperaturbereichs, lässt sich mit Leichtigkeit erzielen. Kompakte Konstruktion, niederer Kraftverbrauch, und schnelles Anheizen vom kalten Zustand sind eine der besonderen Eigenschaften.

Der Ofen betätigt sich bei einer Spannung von 6 V oder 12 V mit einem Kraftverbrauch von 4,6 W, und Temperatureinstellungen von 75°C, 80°C und 85°C stehen zur Verfügung. Die Aufheizzeit ist weniger als 5 Minuten von +20°C bis +85°C. Das Gewicht beträgt 43 g.

EE 8755 *für weitere Einzelheiten*

SUBMINIATURKRISTALLE

Eine neue Reihe von Stecker-Subminiaturkristall-Aggregaten wurde eingeführt. Diese Einheit, Typ 2MM, ist besonders zum Einsatz mit Transistoren und anderen Miniaturbauelementen geeignet. Sie stehen in einem Frequenzbereich von 5 bis 75 MHz (Grundfrequenz 5 bis 20 MHz und Reihenresonanzoberton 15 bis 75 MHz) mit einer Leistung von ±0·005% von −55°C bis 105°C zur verfügung.

EE 8756 *für weitere Einzelheiten*

DAWE INSTRUMENTS LTD (66)

99 Uxbridge Road, Ealing, London, W.5

ABSOLUTEFFEKTIVWERT-RÖHRENVOLTMETER

(Abbildungen auf Seite 237)

Ungleich den gewöhnlichen Röhrenvoltmetern, die Geräte zum Ablesen von Durchnitts- oder Spitzenwerten sind, und deren Eichung für das Ablesen von Effektivwerten eingerichtet ist, misst das absoluteffektivwert Röhrenvoltmeter Typ 612 in genauer Weise den Effektivwert von Wellenformen, die anders als sinusförmig geartet sind. Genaue Effektivablesungen lassen sich für Spannungen und Ströme erzielen, die in Verbindung mit nicht-linearen Geräten oder Schaltungen zur Verwendung kommen. Dreizehn Spannungsbereiche stehen zur Verfügung mit Vollausschlägen von 300 μV, 1 mV, 3 mV, 100 mV, 1 V, 3 V, 10 V, 30 V, 100 V und 300 V. Die Verstärkerwiedergabe schwankt nicht mehr als ±3% von 15 Hz bis 150 kHz und ±5% von 5 Hz bis 500 kHz.

HOCHLEISTUNGS-AUDIOFREQUENZ-OSZILLATOR

(Abbildungen auf Seite 237)

Dieser Oszillator ist ein *RC*-Abgleichungstyp für den Frequenzbereich von 20 Hz bis 20 kHz. Ein Merkmal des Oszillators ist die hohe Ausgangsleistung (6 W), die einer Lastimpedanz von 15Ω oder 600Ω angepasst ist, d.h. ausreichende Kraft zum direkten Betrieb von Lautsprechern oder kleinen Schwingungsgebern. Die Genauigkeit beträgt ±1% im Bereich von 200 Hz bis 2 kHz mit einer Genauigkeit von ±2% in anderen Bereichen.

EE 8758 *für weitere Einzelheiten*

ELECTROTHERMAL ENGINEERING LTD (135)

270 Neville Road, London E.7

PRÄZISIONS-HARTLÖTEGERÄT

(Abbildungen auf Seite 237)

Dieses Gerät wurde entwickelt, um ein leicht bedienbares, tragbares und kräftiges Aggregat zur Verwendung mit Silberhartlötelegierungen zu schaffen. Es ist besonders vorteilhaft für das Hartlöten von Widerstandsdrähten, wie z.B. Nickelchrom und verwandte Legierungen, wo Weichlot entweder schwierig zu verwenden ist oder einen zu tiefen Schmelzpunkt für die betreffende Arbeit aufweist, und wo Punktschweissen eine zu schwache Naht ergibt.

Obwohl es in der Hauptsache für Feinarbeit entworfen ist, von 0,025 mm Durchmesser, kann das Aggregat zum Verlöten von Draht mit einer Stärke bis 10 swg (3,25 mm) Durchmesser verwendet werden.

Der Kraftverbrauch des Aggregats richtet sich nach der Steuerungseinstellung; der Höchstverbrauch beträgt ungefähr 500 W. Das Lötmittel wird vermittels eines sich abnützenden Elements erwärmt, das sich leicht ersetzen lässt. Behälter für Schmelzmittel und für die Lösungen zur Schmelzmittelentfernung sind in bequemer Reichweite des Bedienungsmanns angebracht, wobei die Lösungen arwärmt werden. Das Gerät ist zum Betrieb an jeder beliebigen Wechselstromquelle von 200 bis 250 V ohne Einstellung geeignet, und an weiteren Weshselstromquellen auf Sonderbestellung.

EE 8759 *für weitere Einzelheiten*

FORTIPHONE LTD (152)

92 Middlesex Street, London E.1.

SUBMINIATUR-POTENTIOMETER

Das Subminiatur-Potentiometer und

einpolige Schalter Typ VS 32 besitzt ausserordentlich kleine Abmessungen und ist zur Verwendung in am Kopf befestigten Hörilfen usw. bestimmt. Es ist für Frontund Seitenbefestigung entworfen, wird vermittels einer Mittenschraube und Mutter befestigt und hat einen Gesamtdurchmesser von 8 mm, und eine Tiefe von 3,8 mm. Es kann in Widerstandswerten zwischen 1 kΩ und 3 MΩ und einem Kraftnennwert von 50 mW geliefert werden.

Das Vorwähl - Potentiometer Typ PSR steht für herkömmliche oder gedruckte Schaltungszwecke zur Verfügung. Der Gesamtdurchmesser beträgt 11,4 mm und die Gehäusetiefe beträgt 2 mm. Der Widerstandsbereich und Kraftnennwert sind dieselben wie für den Typ VS 32.

Der Typ PSS ist ein Vorwähl-Gleitdrahtpotentiometer einfacher Konstruktion und Anordnung mit einer Gesamtlänge von 28 mm und Gesamtbreite von 7,2 mm. Der Widerstandsbereich beträgt 1 kΩ bis 3 MΩ und der Kraftnennwert 50 mW.

EE 8760 *für weitere Einzelheiten*

GEO. L. SCOTT & CO. LTD (133)
Cromwell Road, Ellesmere Port, Cheshire

SCHICHT- UND RINGKERNE

Eine Reihe von Subminiatur-Transformatorschiehtgernen steht nunmehr zur Verfügung mit einen Gestamtabmessungsbereich von 25 mm × 19 mm abwärts auf 9,5 mm × 9.5 mm, zum Einsatz in Transistorschaltungen, und überall da, wo die Platzfrage eine Rolle spielt.

Torus-Ringkerne, unter Verwendung von vermittels des Pulvermetallurgieverfahrens hergestellten Nickel-Eisen-Werkstoffen stehen auf keramischen Spulen mit hoher Wärmebeständigkeit, in RCL 193 Grössen auf welche Wicklungen direkt aufgebracht werden können, zur Verfügung. Die Beständigkeit der Kennwerte und die bei Verwendung dieser Legierungen erzielbaren hohen Leistungen machen sich bemerkbar, wo z.B. abgestimmte Paare für Magnetverstärker benötigt werden. Torus-Ringkerne aus Silizium-Eisen-Werkstoffen in Stärken von 0,33, 0,1 und 0,05 mm sind ebenfalls sowahl gemäss RCL 193 als auch nach Angaben der Kunden erhältlich, und zwar für NF- und HF-Kraftquellen.

Schnellschaltende und hochpermeable Bandkerne bis zu einer Mindeststärke von 0,008 mm werden ebenfalls auf keramischen Spulen für Schaltmatrizen und andere Hochleistungs-Magnetgeräte hergestellt.

EE 8761 *für weitere Einzelheiten*

HINCHLEY ENGINEERING CO. LTD (91)
Pans Lane, Devizes, Wiltshire

ISOLIERTRANSFORMATOREN

(Abbildungen auf Seite 238)

Neben einem grossen Bereich von Transformatoren für Radio- und Fernsehzwecke u.s.w. wird ausserdem eine Reihe von Standard-Isolier- und Einspulentransformatoren zum Einsatz in Laboratorien, Werkstätten und Wartungsabteilungen zur Schau kommen. Diese Transformatoren sind alle mit abgesicherten Schnellumschalt - Ausgangsspannungswählern ausgestattet, und sind wahlweise mit 'Mycalex' Schnapnklemmmen lieferbar.

Angesichts der ansteigenden Zahl von elektrischen Haushaltsgeräten zum Einsatz in Werkstatt und Garten sind zwei Ausführungen des Hinchley 'Sicherheits '-Kastens, die tragbare in kräftigen Stahlkästen untergebrachte Isoliertransformatoren sind—(entweder 1 : 1 Verhältnis zur Isolierung von bestehenden Geräten; oder, vorzugsweise, 110 V oder 55 V Ausgang mit Zentralpunkt geerdet) von besonderem Interesse.

Dieselben wurden speziell für Grossmengenfertigung entworfen, so das die Endkosten für den Verbraucher die Sicherheit zu einer wirtschaftlicheren Notwendigkeit gestalten wird.

EE 8762 *für weitere Einzelheiten*

JAMES A. JOBLING & CO. LTD (158)
Wear Glass Works, Sunderland

METALLOXYD-WIDERSTÄNDE

Diese Hochpräzisions-, Hochstabilitäts-Widerstände sind aus 'Pyrex' Stäben hergestellt, auf welche ein dünner Belag von Metalloxyd aufgeschmolzen wird. Der Kern und der Belag sind untrennbar undurchlässig und stabil unter den allerungünstigsten Bedingungen und ihr Rauschpegel ist ausserordentlich niedrig.

Die Standardtoleranz dieser Widerstände beträgt 1% und sie werden vorzugsweise gemäss den genauen Anforderungen der Benützer an Stelle von festgesetzten Werten hergestellt, und zwar in einem Bereich von 100Ω und 250 kΩ, und mit Nennleistungen von 0,5 W bis 2 W.

EE 8763 *für weitere Einzelheiten*

LABGEAR LTD (110)
Willow Place, Cambridge

ZERSTÖRUNGSFREIES BLITZPRÜFGERAT

(Abbildungen auf Seite 238)

Dieses Gerät ist zum Prüfen der Isolierung von Schaltungen und Bauelementen wie Kondensatoren mit niedrigen Spannungen entworfen.

Das Standardmodell gibt Prüfspannungen von 250 V, 500 V, 1 kV, 1,5 kV und 2 kV. Ein Merkmal des Geräts ist, dass es das Prüfen eines Werkstücks mit einer über seiner normalen Betriebsspannung liegenden Spannung ermöglicht, so dass im Falle einer Störung das Prüfstück vollkommen unbeschädigt bleibt und bei einem niedrigeren Potential wieder verwendet werden kann, wodurch es möglich gemacht wird, Werkstücke ohne Zerstörungsgefahr zu sortieren.

EE 8764 *für weitere Einzelheiten*

LUSTRAPHONE LTD (111)
St. George's Works, Regent's Park Road, London, N.W.1

STEREOFONISCHES MIKROFON

(Abbildungen auf Seite 238)

Dieses Mikrofonaggregat besteht aus zwei identischen Bändchen-Geschwindigkeitsmikrofonen, die senkrecht untereinander montiert sind. Die obere Hälfte der Einheit, die eines der Mikrofone enthält, ist so angeordnet, dass sie durchgehend durch einen Winkel von ungefähr 100° von der 'untereinander' Position gedreht werden kann, wodurch ein Höchstmass an Einstellungsmöglichkeiten für jeden Betriebsfall (stereofonische Übertragung, Tonaufnahmen, Senden, Tonverstärkung u.s.w.) erzielt werden kann. Die untere Hälfte des Mikrofons ist ortsfest angebracht.

Das Mikrofon ist mit einem Schalteraggregat verbunden, und zwar vermittels eines Vierwege-Schraubenverbinders. Der Vorteil dieser Methode besteht darin, dass der empfindliche Mikrofonkopf im Nu abgenommen und an einem sicheren Ort aufbewahrt werden kann, ohne Störungen in der Anordnung und den Anschlüssen zum Hauptgerät zu verursachen.

Ein besonders konstruierter Schalter mit drei Positionen wird geliefert:

(1) 'Aus' Position in der Mitte.

(2) Stereo-Anschluss am äussersten Ende einer Seite.

(3) Die andere Position am äussersten Ende der anderen Seite verbindet die beiden Bändchen-Aggregate in Reihenanschluss und verwandelt dadurch das Mikrofon in ein Geradeaus-Bändchengeschwindigkeitsmikrofon mit hoher Empfindlichkeit und einer 'Achter'-Richtcharakteristik.

An der Rückseite des Schalteraggregats ist ein Phasenumkehrschalter vorgesehen, damit zur Erzielung der richtigen Phasenstellung an jedem Gerät augenblickliche Umschaltung gegeben ist.

Wenn das Mikrofon, wie unter (3) oben beschrieben, in seine Stellung verbracht wird, und beide Einheiten sich 'untereinander' befinden, so bewirkt der Phasenumkehrschalter die Umwandlung des Mikrofons in ein rauschunterdrückendes Mikrofon von beträchtlicher Leistungsfähigkeit, das lediglich auf eine sich in nächster Nähe befindliche Schallquelle reagiert.

In Verbindung mit der wechselseitigen Position des Phasenschalters ergibt diesbezügliches Anordnen der Mikrofonaggregate in Zwischenstellungen eine Vielfalt von Richtwirkungen, die sich unter schwierigen akustischen Bedingungen als vorteilhaft erweisen können.

Die Impedanz jedes Mikrofonaggregats im Standardmodell beträgt 20Ω und die Gesamtimpedanz des auf Reihenposition geschalteten kombinierten Geräts beträgt 40Ω.

EE 8765 *für weitere Einzelheiten*

McMURDO INSTRUMENT CO. LTD (32)
Victoria Works, Ashtead, Surrey

RÖHRENFASSUNGEN- UND VERBINDER

Eine neue Reihe von schreibfederartigen Röhrenfassungen unter Verwendung von unbearbeiteten Einzelgiessformen für sowohl die B9A und B7G Version für gedruckte und hergebrachte Schaltungen steht zur Verfügung. Dieselben sind zum Aufnehmen von Röhren-Federhalterungen entworfen, deren Befestigung zusammenhängend mit dem Metallsockel der Röhrenfassung ist.

Darüber hinaus können die Röhren durch billige aufgerollte Abschirmabdeckungen geschützt werden, die eng um den Röhrenkolben anliegen und durch die Federhalterung festgehalten und elektrisch geerdet werden.

Die 'Pakonector' Reihe von Steckern und Sockeln wurde erweitert durch die Einführung einer 8-Wegeversion, die eine der Röhrenfassung B7G ähnliche Grösse aufweist. Derselbe Kabelanschluss und dieselbe Verkapselung wie bei der ursprünglichen 18-Wegeausführung stehen für die 8-Wegeversion zur Verfügung.

EE 8766 *für weitere Einzelheiten*

MULLARD LTD (77, 67)

Mullard House, Torrington Place, London WC1

110° KATHODENSTRAHLRÖHREN

Grössen von sowohl 534 mm als auch 432 mm werden hergestellt, und zwar unter den Typennummern AW53-88 und AW43-88.

Die neuen 110° Röhren sind beträchtlich kürzer als die zur Zeit zur Verwendung kommenden entsprechenden Röhrengrössen, wodurch sich Einsparungen in den Abmessungen zwischen Vorder- und Rückseite bei Fernsehempfängertruhen ermöglichen lassen.

Beim 534 mm Schirm ist die 110° Röhre über 216 mm kürzer als ihr 70° Gegenstück, und 127 mm kürzer als eine 90° Type. Die 432 mm 110° Röhre weist Verminderungen von ungefähr 165 mm bezw. 76 mm gegenüber den entsprechenden Grössen der 70° und 90° Typen auf.

Die neuen Röhren besitzen Hochleistungs-Phosphore mit Metallhinterlegung, und ergeben ausgezeichnete Helligkeit und Kontraste bei starken Innenbeleuchtungen. Sie sind elektrostatisch fokussiert, und umfassen die 'gerade' Elektronenkanonen-Type, die einen Ionenfallen-Magnet überflüssig gestaltet.

EE 8767 *für weitere Einzelheiten*

PAINTON & CO. LTD (29)

Kingsthorpe, Northampton

MINIATUR-HOCHSTABILITÄTSWIDERSTÄNDE

Diese ausserordentlich kleinen Hochstabilitäts-Kohlenstoffwiderstände (Typ 70), messen lediglich ungefähr 9,5 × 2,5 mm, und sind deshalb zur Verwendung in Miniatur-transistorisierten Geräten und insbesondere zum Einsatz bei gedruckten Schaltungsplatinen geeignet. Die Leitungen besitzen einen Vorüberzug von Zinn, um Tauchlöten zu erleichtern. Der Widerstandsbereich umfasst Standardwerte von 5Ω bis 250 kΩ bei einer Toleranz von 5%, aber wenn erforderlich stehen Toleranzen von 1% und 2% für den grösseren Teil des Bereichs zur Verfügung.

EE 8768 *für weitere Einzelheiten*

GEDRUCKTE SCHALTUNGSVERBINDUNGEN

(Abbildungen auf Seite 239)

Eine Anzahl von Verbindungsgliedern für gedruckte Schaltungen wurden eingeführt, einschliesslich eines kräftig konstruierten 15-gängigen Steckers und Steckerleiste mit Stahlstiftbestückung. Zusammen mit den meisten 'Painton' Verbindungsgliedern für gedruckte Schaltungen beruhen die Kontakte auf einem 2,54 mm Modul.

Ebenfalls in der Fertigung befindet sich eine Verbindungsleiste mit bis zu 60 Kontakten in drei Gruppen von 20 mit 2,54 mm Mitten; die Kontakte sind von einzigartiger und patentierter Konstruktion, und Prüfungen haben erwiesen, dass diese Kontaktform eine lange Standzeit der Platineneinsteckung gestattet.

EE 8769 *für weitere Einzelheiten*

RECHTWINKLIGE RÖHRENFASSUNGEN

(Abbildungen auf Seite 239)

Diese Bauelemente wurden dafür entworfen, waagrechten Einbau von Röhren zu gestatten, und auf diese Weise die Fertigung von gedrungeneren gedruckten Schaltungsmontagen zu erleichtern und Wärmeableitanordnungen zu vereinfachen.

Die Kontakte bestehen aus silberüberzogenem Berylliumkupfer und sind lang genug, um sich für die meisten gewöhnlich zur Verwendung kommenden Stärken von gedruckten Schaltungsplatinen zu eignen. Die korrekten Einführungs- und Abnahmedrücke werden bei einem Mindestmass an Kontaktwiderstand aufrechterhalten.

EE 8770 *für weitere Einzelheiten*

STEATITE AND PORCELAIN PRODUCTS LTD (76)

Stourport-on-Severn, Worcestershire

KLEMMENPLOMBEN

(Abbildungen auf Seite 239)

Im Anschluss an die letztjährige Vorankündigung wird die neue Reihe von Klemmenplomben die entsprechend den Anforderungen der 'Streitkräfte'—Norm RCL 331 entworfen wurden, zur Schau kommen. Dieselben sind aus hochwertigen Alumina-Keramikwerkstoffen hergestellt, und die Ableitungen sind fest in ihrer Stellung vermittels Schmelzglasur eingeschmolzen. Bänder mit Metallüberzug, die vermittels eines für den erforderlichen Gütegrad genehmigten Nickel-überzugverfahrens hergestellt werden, gestatten Weichlöten direkt in Metallhülsen für alle hermetischen Abdichtungsverwendungen.

Die Standardreihen von Plomben mit Nickellüberzug, die für die H1 Gütegruppe genehmigt sind, stehen noch ab Lager zur Verfügung, und eine Musterabteilung stellt Grundtypen von neuen Entwürfen in kürzester Zeit her. Besonderes Augenmerk wurde auf verbesserte Vorrichtungen für die Montage von metallüberzogenen keramischen Erzeugnissen mit geeigneten Metallbauteilen gerichtet, um eine grosse Vielfalt von Verwendungszwecken, angefangen von Miniaturableitungen bis zu grossen Hochspannungs-Kondensatorklemmen, zu erfassen.

EE 8771 *für weitere Einzelheiten*

SWIFT LEVICK & SONS LTD (156)

Clarence Steel Works, Sheffield, 4

GROSSE DAUERMAGNETE

(Abbildungen auf Seite 240)

Sehr grosse und stabile Dauermagnete werden jetzt mit Feldern hoher Homogenität für magnetische Kernresonanzzwecke hergestellt. Die Fotografie zeigt einen solchen Magnet, der für Forschungszwecke für der Universität von Leeds etworfen und hergestellt wurde. Dieser Magnet wiegt 2,350 kg, und seine Gesamtabmessungen betragen 1 210 × 1 070 × 610 mm; die Dauermagnetisierung geschieht vermittels von Clumax-Legierung, der stabilste und stärkste Magnetwerkstoff, der zur Zeit handelsmässig auf der ganzen Welt hergestellt wird. Der Magnet hat eine Spaltfeldstärke von 9 700 Oe innerhalb eines Spaltraums von 36 mm lang × 254 mm Durchmesser, und die Feldgleichheit ist besser als ein Teil in 10^6 innerhalb eines mittleren Raums von 1 cm^3. Besondere mechanische Justierungen sind an einem der eisernen Polteile vorgesehen, wodurch eine beschränkte Bewegungsfreiheit der Poloberfläche in jeder beliebigen Ebene für das endgültige Einstellen der Spaltfeldstärke gestattet ist.

Ein Modell dieses Magnets im Masstab 1:6 kommt zur Ausstellung.

EE 8772 *für weitere Einzelheiten*

TELEPHONE MANUFACTURING CO. LTD (21)

Hollingsworth Works, London, S.E.21

MEHRFACHRELAIS

(Abbildungen auf Seite 240)

Das neue zehngängige Mehrfachrelais wird zur Schau kommen. In diesem neuen Relais kommen viele einzigartige und neuartige Methoden zur Verwendung, die sowohl niedere Kosten als auch erhöhte Zuverlässung mit sich bringen. Das Mehrfachrelais TMC verwendet einen gemeinsamen Steg mit Montagestützen, und ist zum Ersatz von Relais der Telefontype in Steuerschaltungen bestimmt, wo der Kostenpunkt an erster Stelle steht.

Kontaktfedern aus Phosphorbronze, mit Silber-Bimetallkontakten unter Anwendung der Kreuzradienmethode, und automatische Maschineneinstellung und Kartenbetrieb gewährleisten einen stetigen Kontaktdruck, wie er bisher nur in teuren Präzisionsrelais zur Verfügung stand. Eine leistungsfähige magnetische Schaltung gewährleistet, dass magnetische Einwirkungen zwischen Relais so gut wie nicht auftreten, während die Montagestützen mit gemeinsamem Steg die Anzahl der Einzelbestandteile beträchtlish verringern und die Notwendigkeit für getrennte Montageteile überflüssig gestalten.

Der Preis dieses Mehrfachrelais ist so gehalten, dass es sich oft wirtschaftlicher erweist, eine zehngängige Einheit an Stelle einer geringeren Anzahl von herkömmlichen Relais anzubringen.

EE 8773 *für weitere Einzelheiten*

ELECTRONIC ENGINEERING bietet Ihnen . . .

Eine Gesamtverbreitung von über 11,000 bezahlten Exemplaren pro Monat auf der ganzen Welt.

Einen Vertrieb unter 86 Industriegruppen in 70 Ländern.

Einen Leserdienst der Anfragen augenblicklich bringt und weiterleitet.

Der Gemeinsame Markt in Europa

Die Weltverbreitung der bezahlten Exemplare erstreckt sich auf die Länder des Gemeinsamen Marktes in Europa—Frankreich, Deutsche Bundesrepublik, die Niederlande, Italien, Belgien und Luxemburg.

Nach angestellten Schätzungen gibt es in dem Gemeinsamen Markt in Europa 250,000,000 mögliche Kunden. Diese Anzahl wird sich noch mehr steigern, falls und wann das europäische Freihandelsgebiet (das Grossbritannien und die skandinavischen Länder umfassen wird) Tatsache wird. Die Elektronik wird dazu beitragen, die zur Versorgung dieses ungeheuren Marktes erforderlichen Waren herzustellen.

"ELECTRONIC ENGINEERING" hat bereits eine Verbreitung von über 1,600 direkten Abonnenten in Europa. In dem Masse, in dem sich der Austausch von Waren und Dienstleistungen zwischen den Ländern des Gemeinsamen Marktes in Europa steigert, wird sich unter den Wissenschaftlern und elektronischen Ingenieuren dieser Länder die Nachfrage für die Zeitschrift erhöhen.

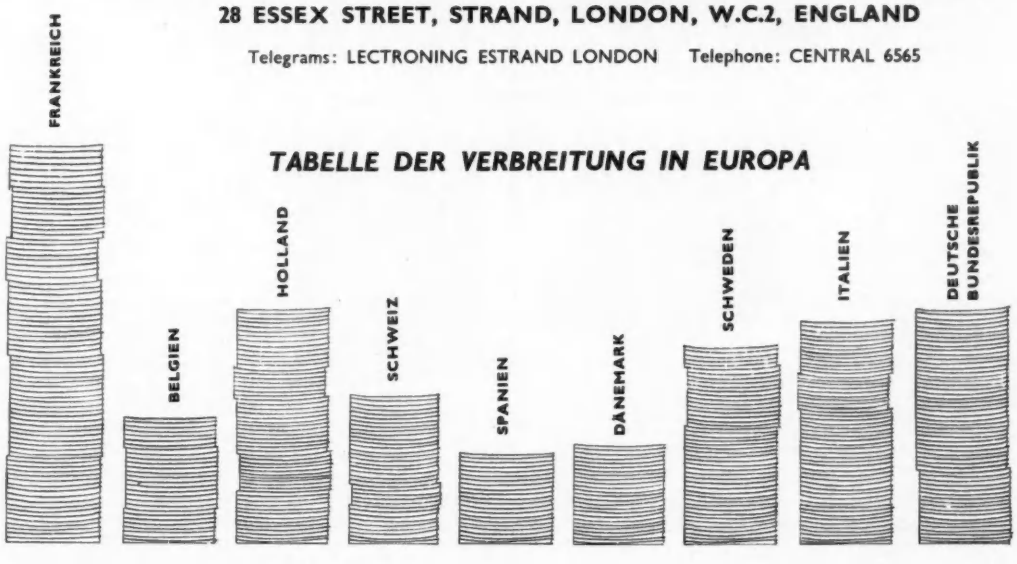
Wegen weiterer Einzelheiten wenden Sie sich bitte an THE ADVERTISEMENT MANAGER:—

Electronic Engineering

28 ESSEX STREET, STRAND, LONDON, W.C.2, ENGLAND

Telegrams: LECTRONING ESTRAND LONDON Telephone: CENTRAL 6565

TABELLE DER VERBREITUNG IN EUROPA



EE 8110 *for further details*

SOLARTRON

EIN BEGRIFF FÜR ELEKTRONISCHE GERÄTE HÖCHSTER GÜTE

Die Solartron-Elektronen-Gesellschaft, eine der führenden Herstellerfirmen von Elektron-Apparaten in Europa, bietet Ihnen in Ihrem eigenen Land technische Hilfe und fachmännischen Rat für die Verwendung sämtlicher Elektron-Messgeräte an.

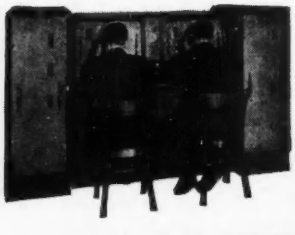
Überall in der Welt sind die Solartron-Elektron-Messgeräte in Gebrauch, und die Nachfrage wächst ständig. Absolute, relative und vektorielle Messungen; visuelle Analysen und Darstellungen (durch Oszilloskope); schnelle Schätzungen von Servoelementen und Dynamiksystemen; die Kontrolle des Nachrichtennetzes—dieses und eine grosse Menge anderer Forschungs-und Produktions-Testarbeiten werden täglich mit Hilfe der Solartron-Präzisions-Messgeräte durchgeführt.

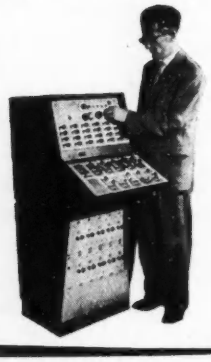
Eine neue Art "SPACE" Analog-Kalkulatoren ist kürzlich eingeführt worden; zu anderen, von eigener grösster Bedeutung zählenden Apparaten gehören ERA—der Solartron-Elektron-Ableseautomat; Radar-Simulator-Systeme; "SAKI", ein Gerät, das zur Ausbildung von Arbeitern für die Bedienung von Lochkartenmaschinen verwendet wird—und Kontrollgeräte für die Industrie, wie z. B. der automatische Fluoreszenz-Röntgen-Spektrometer und der Elektron-Schnellauf-Gewichtprüfer. Zusätzlich stehen stabilisierte Energiequellen in vollem Umfange für die Einrichtung normaler Anlagen oder solcher mit Transistor zur Verfügung.

Der stabile Ruf, den die gesamte Solartron-Produktion für die Leistungsbeständigkeit ihrer Geräte, Mass-und Bezeichnungsgenauigkeit mit unbedingter Zuverlässigkeit sogar unter den schwierigsten Betriebsverhältnissen—erworben hat, ist auf die präzisen Herstellungnormen auf dem technischen als auch dem mechanischen Gebiet zurückzuführen. Dieses wird durch die Verleihung der J.S.A.-Auszeichnung (Joint Service Approval), eine Zustimmung der Regierung für den Geländeeinsatz dieser Geräte durch die Vereinigten Britischen Streitkräfte, deutlich unterstrichen.

Solartron Simuliersysteme für Radareinrichtungen

Typische Einheiten eines Simulations-Systems mehrerer Objektive stehen im Dienst der NATO-Länder. Dieses System kann jeder vorhandenen Radarvorrichtung angepasst werden.



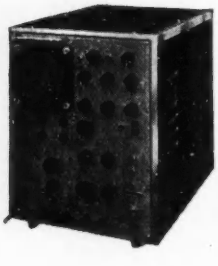


Solartron MINISPACE-Analog-Kalkulator TY 864

Typische Maschine für die schnelle Lösung komplizierter Probleme der Dynamik, Datenreduktion, Simulierung von Kontrollsystemen, etc.

Sub-Einheit für stabilisierte Energiequellen AS 850

Ein impedanzloser Apparat: einer der 30 Solartron-Typen für Energiequellen. Varianten mit Transistor können auch geliefert werden.



SOLARSCOPE CD 643.2 (CT 380)

Ein Mess-Oszilloskop für Höchstpräzision, verwendbar für Feinmessungen von "X"—und "Y"—Achsen; bereits in Produktion.

Brauchen sie fachmännische, kompetente Ratschlage oder Auskünfte hinsichtlich der neuesten Elektron-Entwicklung? Bitte, setzen Sie sich noch heute mit Solartron in Verbindung! Eines der vielen Probleme, die wir bereits erfolgreich bearbeitet haben, kann auch Ihr Problem sein.

SOLARTRON ELEKTRONIK G.m.b.H.
München 15, Bayerstrasse 13, Deutschland
Telefon: München 59.51.09

THE SOLARTRON ELECTRONIC GROUP LTD
THAMES DITTON · SURREY · ENGLAND
Telefon: EMBerbrook 5522 Internationaler Fernschreiber: 23842
Telegramme: Solartron Thames Ditton Solartron T. Dit.

WHITELEY ELECTRICAL RADIO CO. LTD (81)

Radio Works, Victoria Street, Mansfield, Nottinghamshire

KABELPRÜFGERÄT

(Abbildungen auf Seite 240)

Dieses Prüfgerät bestimmt die Lage von Bruchstellen oder Kurzschlüssen in ummantelten vieladrigen Leitungskabeln bis auf den Bruchteil eines Zolls. Reparaturen können dann mit einem Mindestmass von Beschädigung des Kabelmantels ausgeführt werden.

Das Betriebsprinzip ist wie folgt: Im Falle eines Leitungsbruchs wird eine Tonfrequenzspannung zwischen einem Ende der Leitung und Erde angelegt; das elektrostatische Feld zwischen dem unter Strom stehenden Abschnitt der Leitung und Erde lässt sich dann durch das Entlangführen einer kapazitiven Sonde bestimmen. Die Sonde ist an den Eingang eines trgbaren Transistorverstärkers angeschlossen, der ein Kopfhörergerät speist und auf diese Weise eine hörbare Anzeige der Bruchstelle ergibt. Alle anderen Leitungen im Kabel müssen geerdet sein, mit Ausnahme der sich unter Prüfung befindlichen.

Eine induktive Sonde wird an Stelle der kapazitiven Sonde zum Auffinden von Kurzschlüssen zwischen Leitungen verwendet. Der Oszillator speist ein Signal in die Leitung nur bis zu der Stelle, wo der Kurzschluss auftritt, und die Sonde bestimmt dann das elektrostatische Feld bis zu dieser Stelle.

Das Prüfschaltbrett ist mit Drehschaltern bestückt, um das Wählen von Einzelleitungen im Kabel zu ermöglichen. Alle Leitungen mit Ausnahme der unter Prüfung stehenden sind geerdet. Steckdosen zur Aufnahme der Kabelstecker sind angebracht. Zur anfänglichen Bestimmung einer schadhaften Leitung ist eine leuchtenähnliche Stetigkeitsprüfvorrichtung vorgesehen.

Der Röhrenoszillator ist batteriebetrieben und besitzt eine Ausgangsleistung von 10 mW mit einer Ausgangsimpedanz von 300Ω. Seine Frequenz beträgt 1 kHz ±2½%. Je nach der Einstellung des Potentiometers kann die Art der Schwingung entweder andauernd oder unterbrochen sein.

Der Transistorverstärker wird mittels einer im Gehäuse untergebrachten 4½ V-Batterie betrieben und hat eine Gesamtverstärkung von 70 dB, bei einer nichtinduktiven Ausgangslast von 300Ω.

Die induktive Sonde ist auf 1 × kHz ±2½% abgestimmt.

EE 8774 *für weitere Einzelheiten*

THE ZENITH ELECTRIC CO LTD. (8)

Zenith Works, Villiers Road, Willesden Green, London, N.W.2

REGELTRANSFORMATOREN

(Abbildungen auf Seite 240)

Ein neues 'Variac' Modell 50-B/2B mit Doppelausgang wird ausgestellt werden. Dasselbe ist für einen Kraftanschluss von 230 V 50 Perioden entworfen, wodurch sich eine zwischen null und 270 V regelbare Leistung ergibt, mit einem Höchstnennstrom von 20 A, was den Gesamtwert darstellt, der den beiden Bürsten entnommen werden kann, aber die Last lässt sich natürlich verteilen, um Anwendungsforderungen wie z.B. 1-12 A für Ausgang Nr.1, und 8 A für Ausgang Nr.2 zu entsprechen. Die Doppelbürsten, Doppelausgang 'Variacs' stehen seit einiger Zeit in den Reihen '100' und 'V30H', und ausserdem in dem kleineren Torusbereich in der Reihe '200' zur Verfügung.

Diese kleineren Typen wurden nunmehr unter Verwendung von Bauelementen der 'V5' Reihe neu entworfen, wodurch die Fertigung eines kompakteren Typs ermöglicht wird.

EE 8775 *für weitere Einzelheiten*

ERDUNGSSCHLEIFEN-PRÜFGERÄT

Dasselbe ist in einen Metallschrank, komplett mit Traggriff und einer Tasche für ein Zuleitungskabel und Zwischenstecker, untergebracht. Es ist für das Vornehmen aller in der I.E.E. Vorschrift Nr.507 festgelegten Prüfungen, und zum Betrieb von einer Standard-Einphasenquelle entworfen, mit einer Ausgangsleistung von 25 A und jeder beliebigen Spannung zwischen null und 40 V.

Ein 'Zenith' Abwärtstransformator mit Doppelwicklung kommt mit einen 'Variac' über der Primärwicklung zur Verwendung, und ausserdem ein Doppelbereich-Gleichrichtervoltmeter zusammen mit einem Ammeter; wir liefern je eine 13 A und 15 A Dreikontaktstift-Steckdose an der Vorderseite des Gehäuses für Erdkernprüfungen tragbarer Geräte. Das 40 V Gerät ist für die meisten Prüfarbeiten erhältlich, aber 6 V is mit eingeschlossen, das sich dies für kurze Erdungsschleifen wie z.B. bei tragbaren Werkzeugen und anderen ähnlichen Geräten als geeigneter erweisen mag.

Ein Verbindungsglied zum Prüfen von ortsfesten Geräten ist eingebaut, für welches das 6 V verwendet werden soll, da die Erdleitung verhältnismässig kurz ist und 0,1Ω, was einen Wert von ungefähr 3 V darstellt, nicht übersteigen darf.

EE 8776 *für weitere Einzelheiten*

Berichtisung

Wir bedauern, dass in der Beschreibung des 'Magnetband-Speichers' der Firma Epsylon Industries Ltd auf Seite 188 unserer März-Ausgabe die Bandgeschwindigkeiten unrichtig angegeben wurden. Die richtigen Werte sind:—

Standard-Bandgeschwindigkeit — 254 cm/Sek.

Zukünftige Bandgeschwindigkeit — 508 cm/Sek.

Schnellaufspulung—1 016 cm/Sek.

Zusammenfassungen der Hauptartikel

Lineare Mehranzapfstellen-Potentiometer mit belasteten Ausgängen von K. C. Garner

Zusammenfassung des Artikels auf Seite 192-199

Eine Analyse von Mehranzapfstellen-Potentiometern wird hier gegeben, und zwar für die Type, wo Shunt-Widerstände zwischen angrenzenden Anzapfstellen angeschlossen sind, und beim Vorhandensein eines Ausgangsbelastung-Widerstands.

Bei Verwendung eines Allgemeinnetzes mit entsprechenden ziffernmässigen Einsatzwerten, die aus der in Frage stehenden Potentiometeranordnung ermittelt werden, gestaltet sich die Auswertung einfach und systematisch.

Ein Verfahren für den Entwurf von Potentiometern zum Erzeugen von nicht-linearen Funktionen wird vorgeschlagen.

Aufschlaggeräusch-Analyse von F. M. Savage

Zusammenfassung des Artikels auf Seite 200-203

Geräte für das Messen und die Analyse von anhaltenden Geräuschen haben es ermöglicht, Normen zum Vermeiden von Gehörbeeinträchtigung bei Personal aufzustellen, das ständigen Geräuschen ausgesetzt ist. Die Entwicklung von Analysiergeräten für Aufschlaggeräusche dürfte die erforderlichen Unterlagen zur Behandlung der sogar noch gefährlicheren Aufschlaggeräusche erbringen. In diesem

Artikel wird ein kleines tragbares Gerät zum Messen von kury anhaltenden Geräuschen beschrieben. Das Gerät kann auch für andere Zwecke verwendet werden, wie z.B. das Messen von Spitzenbeschleunigungen, wenn es mit einem geeigneten Beschleunigungsmesser verwendet wird.

Transistorverstärker für Magnetband-und Trommelabspielgerät von A. E. Bachmann

Zusammenfassung des Artikels auf Seite 213-217

Magnetbänder- und Trommeln werden häufig als Speicheröder Übertragungselemente verwendet, wobei die Information in digitaler Form enthalten ist. Diese Information lässt sich durch Abspielen des Bands oder der Trommel durch einen Magnetkopf und Verstärker wieder zur Verfügung stellen. Der Artikel bespricht die mit der Konstruktion eines solchen Verstärkers verbundenen Probleme, wenn lediglich Transistoren verwendet werden. Ein Grundtyp wurde geprüft, der von einem Abspielkopf betätigt wird und eine Arbeitsstrom-Ausgangsspannung von mehr als 2 mV aufweist. Er ist in der Lage, drei bistabile Multivibratoren in Parallelschaltung innerhalb eines Frequenzbereichs von 2 bis 400 kHz und einem Temperaturbereich von 0°C bis +70°C zu betätigen. Die Anstiegzeit des Ausgangsimpulses beträgt weniger als 1 μSek.

Ein einfacher NF-Oszillograph von J. F. Young

Zusammenfassung des Artikels auf Seite 218-220

Die gewöhnlichen Methoden der Stabilisierung von RC-Oszillographen sind frequenzempfindlich. In dem beschriebenen einfachen Oszillograph begrenzt eine Zener-Diode die Amplitude and die sich ergebenden Oberwellen werden vermittels eines Wählkreises, der ausserdem die Schwingungsfrequenz steuert, ausgefiltert. Eine annehmbare Wellenform lässt sich deshalb selbst bei sehr niederen Frequenzen erzielen.

Eine stroboskopische Methode zum Vornehmen von Frequenzwiedergabe-Messungen an kleinen elektro-mechanischen Vorrichtungen von M. Sheperdson und R. Walters

Zusammenfassung des Artikels auf Seite 220-221

Eine Methode zum Vornehmen von Frequenzwiedergabe-Messungen an kleinen elektro-mechanischen Vorrichtungen unter Verwendung eines beweglichen Mikroskops und einer stroboskischen Lampe wird beschrieben. Abgesehen von einem einfachen Impulsverstärker- und Phasenverschiebungsnetz, das beschrieben wird, steht die erforderliche Apparatur in den meisten gut ausgestatteten elektrischen Laboratorien zur Verfügung. Die Methode erfordert kein Einspannen des Prüflings und gestattet das Vornehmen von Amplitudenmessungen weit unter 0,025 mm.

Regulierte Stromquellen von D. J. Collins und J. E. Smith

Zusammenfassung des Artikels auf Seite 222-226

Regulierte, oder stabilisierte Gleichstromquellen werden für eine Reihe von Zwecken benötigt. In diesem Artikel werden verschiedene Typen von Regulatoren kurz besprochen und der Reihenstabilisator mit geschlossener Schleife wird etwas ausführlicher behandelt. Die Konstruktionsprobleme dieser Aggregattype werden untersucht und der Schleifenstabilität wird besondere Beachtung geschenkt. In einem Anhang wird der Entwurf einer typischen Einheit in allen Einzelheiten gezeigt.

Telemetrische Verfahren unter Verwendung des Grundprinzips der gasgefüllten Stufenröhre von Yoshisuke Hatta

Zusammenfassung des Artikels auf Seite 227-229

Ein telemetrisches Verfahren zum Ermitteln von mechanischer Verschiebung unter Verwendung des Grundprinzips der gasgefüllten Stufenröhre wird beschrieben. Da es sich um ein elektronisches Gerät handelt, besitzt es eine vorteilhafte hohe Betriebsgeschwindigkeit, und ist deshalb in mancher Beziehung elektromagnetischen Systemen, denen beträchtliche Trägheit zu eigen ist, überlegen.

Feste elektrolytische Tantalkondensatoren von R. Aries

Zusammenfassung des Artikels auf Seite 230-231

Feste elektrolytische Tantalkondensatoren haben bereitwillige Aufnahme für die Verwendung in miniaturisierten Geräten gefunden. In diesem Artikel wird eine kurze Beschreibung des Fertigungsverfahrens zusammen mit den Ergebnissen von Lebensdauerprüfungen und Temperaturkennwerten gegeben.

E M I

MAGNETIC RECORDING TAPES
MAGNETBÄNDER
RUBANS MAGNETIQUES E.M.I. POUR L'ENREGISTREMENT

Emitape

for tape recording
für Tonaufnahmen auf Magnetband
pour l'enregistrement au magnétophone

The world-famous magnetic recording tape offering the highest technical standards and used by leading recording and broadcasting organisations, industry and science. "77" pen tested. "88" general purpose. "99" Long Play.

Dieses technisch erstklassige, weltberühmte Magnetband wird von den führenden Konzernen des Rundfunks und der Industrie sowie von wissenschaftlichen Körperschaften für ihre Aufnahmen benutzt. "77" mit Feder geprüft. "88" für alle üblichen Anwendungen. "99" für langspielende Aufzeichnung.

Ce ruban magnétique, célèbre dans le monde entier et dont la qualité technique est incomparable, est utilisé par les principales maisons d'enregistrement, ainsi que par les stations radiophoniques et les installations scientifiques. "77" éprouvé à la plume. "88" pour l'emploi général. "99" longue durée.

EMITAPE
INSTRUMENTATION TAPE

for computers, instrumentation and telemetry
für Rechenmaschinen, Apparaturen und Fernmessgeräte
pour les computeurs, l'instrumentation et la télémetrie

Produced to the most exacting specification and available in various standard widths. To obtain the greatest freedom from surface contamination vital in these applications of tape recording a system of electrostatic filtration, down to a particle size of .00001 mm, at the E.M.I. tape plant ensures that all stages of manufacture are carried out under the cleanest possible conditions.

Dieses Magnetband wird mit der höchsten Präzision in verschiedenen Normalbreiten hergestellt. Um die Oberfläche so rein zu halten, wie es für diese Anwendungsgebiete der Magnetbandaufzeichnung unerlässlich ist, sorgt ein elektrostatisches Filtriersystem, das Teilchen bis zu 0,00001 mm erfasst, in der E.M.I. Magnetbandfabrik dafür, dass alle Stufen der Herstellung unter den denkbar saubersten Verhältnissen ausgeführt werden.

Ce ruban est produit conformément aux données de la plus haute précision et existe en différentes largeurs standards. Pour réduire au minimum la contamination de surface—condition indispensable à ces applications de l'enregistrement sur ruban un système de filtration électro-statique allant jusqu'aux particules de 0,00001 mm. assure aux ateliers de fabrication E.M.I. les conditions les plus favorables à la production des rubans.

EMIFILM

for cinematographic and teleciné uses
für Film und Fernsehen
pour les utilisations cinématographiques et télé-cinématographiques

Sprocketed magnetic recording film designed for all applications where absolute synchronisation is required. The special micro-polish finish reduces head wear by as much as 30%. 16, 17·5 and 35 mm; fully coated only. Single or double perforation. Supplied wound oxide "in" or oxide "out".

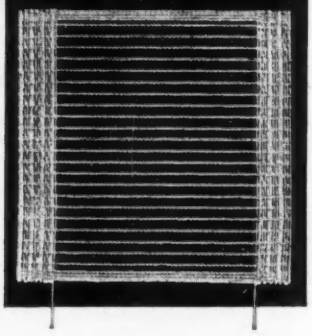
Perforierte Magnetbänder dienen für alle Anwendungen, bei denen es auf vollkommene Synchronisierung ankommt. Die besondere Hochglanz-Politur des Bandes verringert die Abnutzung des Tonkopfes bis um 30%. Die Magnetbänder sind nur ganz beschichtet in 16 mm, 17,5 mm und 35 mm Breite erhältlich. Sie werden sowohl einseitig wie beiderseitig perforiert und sind, je nach Bestellung, mit der Oxyd-Schicht "innen" oder "aussen" gewickelt erhältlich.

Film d'enregistrement magnétique à chaîne étudié pour toutes les applications nécessitant une synchronisation absolue. Le fini spécial micro-poli réduit jusqu'à 30% de la fatigue de tête. 16, 17,5 et 35 mm., à revêtement entier seulement. Perforation simple ou double. Fourni enroulé oxyde "à l'intérieur" ou oxyde "à l'extérieur".

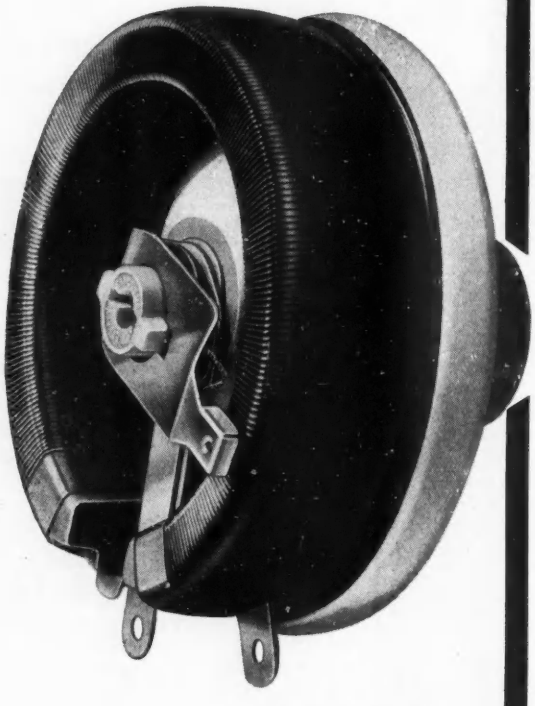
Full details from:
Nähere Einzelheiten erhalten Sie von:
Pour tous détails, s'adresser à:

E.M.I. SALES & SERVICE LTD · HAYES · MIDDLESEX · ENGLAND

ES/R/48



✳ *A Cressall asbestos woven net. One of many types developed and backed by 45 years' experience.*



✳ *A Cressall Torostat. A toroidally wound vitreous enamelled rheostat for long service and accurate control*

. . . from the largest
. . . to the smallest ✳

RESISTORS

Expamet-Cressall make and supply electrical units to handle every electrical loading from over 20,000 kilowatts to as low as 4 watts . . . whilst it is unlikely that you will require the larger resistors, it is good to know that in Expamet-Cressall you have a simple, reliable organisation, more than equipped to meet all your specialised needs.

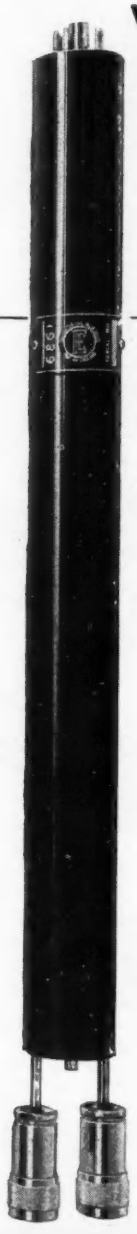
EXPAMET-CRESSALL go together all the way

Expamet **Cressall**

The Electrical Division of The Expanded Metal Company Ltd.

London Office: Burwood House, Caxton St., London, S.W.1. Telephone: ABBey 7766.
Works: Stranton Works, West Hartlepool. Telephone: Hartlepools 5531.
The Cressall Manufacturing Company Ltd., Eclipse Works, Tower St., Birmingham 19. Telephone: Aston Cross 2666.

TRAVELLING WAVE TUBES FOR COMMUNICATIONS AND RADAR



Quick delivery is available for our travelling wave tubes, which are designed for use in microwave links and radar receivers.

For links in the frequency bands 1700 to 2300 Mc/s and 3800 to 4200 Mc/s, we are manufacturing power output tubes, low noise input tubes and intermediate driver tubes.

The table below gives brief specifications for these types as well as for low noise tubes for radar receivers. All types listed are currently in production and are giving excellent results in operational equipment.

Details of power supplies available on request.

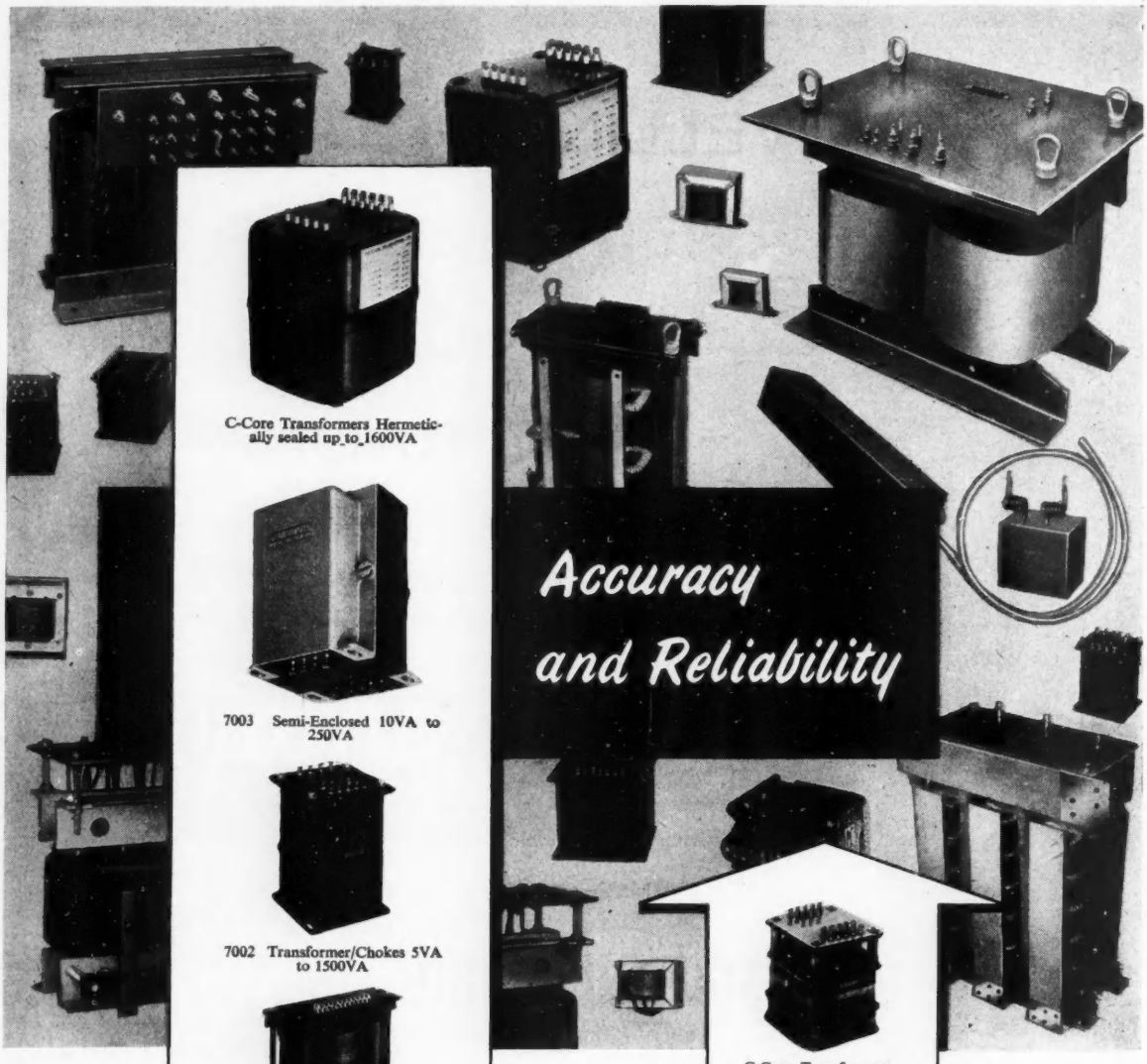
'ENGLISH ELECTRIC'

Type	Application	Frequency band	Power Output	Noise Factor (db)	Gain (db)
N1001	radio links	1700 to 2300 Mc/s	16W	—	25
N1013	,,	1700 to 2300 Mc/s	200mW	20	33
N1002	,,	1700 to 2300 Mc/s	1mW	9	23
N1004	,,	3800 to 4200 Mc/s	4W	—	24
N1023M	,,	3800 to 4200 Mc/s	4W	—	24
N1025M	,,	3600 to 4200 Mc/s	75mW	21	32
N1024M	,,	3600 to 4200 Mc/s	1mW	9	20
N1017M	radar input	1200 to 1400 Mc/s	0.3mW	8	23
6861	,,	2700 to 3500 Mc/s	1mW	6.5	25

Type 6861 and those with subscript M are fitted with coaxial connectors for which lightweight electromagnets are available. Other types are normally used in waveguide installations

ENGLISH ELECTRIC VALVE CO. LTD. *Chelmsford, England*
Telephone: Chelmsford 3491

AP 300/119A



C-Core Transformers Hermetically sealed up to 1600VA

7003 Semi-Enclosed 10VA to 250VA

7002 Transformer/Chokes 5VA to 1500VA

Saturable Reactors up to 100kVA

Accuracy and Reliability

C-Core Transformers Open Type up to 1600VA

3-Phase Power Transformers up to 100kVA

7016 Open Type 10VA to 250VA

7008 Core Shroud 2VA to 100VA

HADDON TRANSFORMERS

HADDON TRANSFORMERS LIMITED
MASONS AVENUE, WEALDSTONE, HARROW, MIDDX.
Telephone: Harrow 9022-5

SEE US AT STAND 16
R.E.C.M.F EXHIBITION
APRIL 6th to 9th
GROSVENOR HOUSE, W.1.

EE 8115 *for further details*

A COMPLETE RANGE OF VACUUM TUBE REGULATED SUPPLIES

WITH THESE FEATURES . . . .

FREQUENCY RESPONSE—complete stability from 1 c.p.s. to beyond 100 k.c.s.

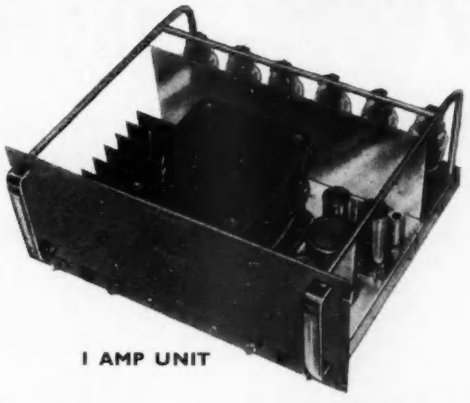
STABILITY—guaranteed for ± 10% mains variation—double triode difference amplifiers ensure freedom from drift.

LIFE—conservatively rated components ensure long life.

IMPEDANCE—a preset potentiometer allows for smooth impedance adjustment from positive to negative values.

MAINS—200/250 V.A.C. (115V models available).

FRONT PANEL UNITS—fitted with Plessey Mark IV or Films & Equipment Jones type plugs & sockets. Please state preference.



1 AMP UNIT

Model	D.C. Output		A.C. Outputs	Effective Resistance	Voltage Stability	Ripple	Size	Price Ex-works
	Volts	Currents						
OPEN CHASSIS UNITS								
M23	±150V	0-50mA	6.3V2A & 6.3V1A	<0.1 Ω	<0.02%	<1mV	6″×5½″×5¾″ ht.	£30-0-0
M23A	±200V	0-50mA	6.3V2A & 6.3V1A	<0.1 Ω	<0.02%	<1mV	6″×5½″×5¾″ ht.	£27-10-0
M33	±250V	0-50mA	6.3V2A & 6.3V1A	<0.1 Ω	<0.02%	<1mV	6″×5½″×5¾″ ht.	£30-0-0
M14A	±100V	0-100mA	2×6.3V3A C.T.	<1.0 Ω	<0.02%	<1mV	10¼″×7″×6⅛″ ht.	£63-0-0
M24	±150V	0-100mA	2×6.3V3A C.T.	<0.1 Ω	<0.02%	<1mV	7⅜″×6¾″×6¼″ ht.	£33-10-0
M24A	±200V	0-100mA	2×6.3V3A C.T.	<0.1 Ω	<0.02%	<1mV	7⅜″×6¾″×6¼″ ht.	£33-10-0
M34	±250V	0-100mA	2×6.3V3A	<0.1 Ω	<0.02%	<1mV	7⅜″×6¾″×6¼″ ht.	£33-10-0
M34A	±300V	0-100mA	2×6.3V3A	<0.1 Ω	<0.02%	<1mV	7⅜″×6¾″×6¼″ ht.	£33-10-0
M25	±150V	0-200mA	2×6.3V3A C.T.	<0.1 Ω	<0.02%	<1mV	8¾″×8½″×5¾″ ht.	£52-10-0
M25A	±200V	0-200mA	2×6.3V3A C.T.	<0.1 Ω	<0.02%	<1mV	8¾″×8½″×5¾″ ht.	£52-10-0
M35	±250V	0-200mA	2×6.3V3A	<0.1 Ω	<0.02%	<1mV	8¾″×8½″×5¾″ ht.	£52-10-0
M35A	±300V	0-200mA	2×6.3V3A	<0.1 Ω	<0.02%	<1mV	8¾″×8½″×5¾″ ht.	£52-10-0
M26SA	±200V	0-500mA	2×6.3V5A C.T.	<0.1 Ω	<0.02%	<1mV	14″×11½″×8½″ ht.	£88-0-0
M36S	±250V	0-500mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	14″×11½″×8½″ ht.	£88-0-0
M36SA	±300V	0-500mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	14″×11½″×8½″ ht.	£88-0-0
M28A	±200V	0-350mA	2×6.3V5A C.T.	<0.1 Ω	<0.02%	<1mV	13½″×8¾″×6¾″ ht.	£66-0-0
M38	±250V	0-350mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	13½″×8¾″×6¾″ ht.	£66-0-0
M38A	±300V	0-350mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	13½″×8¾″×6¾″ ht.	£66-0-0
19 in. FRONT PANEL UNITS								
M26A	±200V	0-500mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×12″×8¾″ ht.	£97-10-0
M36	±250V	0-500mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×12″×8¾″ ht.	£97-10-0
M36A	±300V	0-500mA	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×12″×8¾″ ht.	£97-10-0
M27A	±200V	0-1.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×15¾″×8¾″ ht.	£165-0-0
M37	±250V	0-1.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×15¾″×8¾″ ht.	£165-0-0
M37A	±300V	0-1.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×15¾″×8¾″ ht.	£165-0-0
M29A	±200V	0-2.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×18″×10½″ ht.	£255-0-0
M39	±250V	0-2.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×18″×10½″ ht.	£255-0-0
M39A	±300V	0-2.0A	2×6.3V5A	<0.1 Ω	<0.02%	<1mV	19″×18″×10½″ ht.	£255-0-0

M14A UNIT

MADE AND GUARANTEED BY

ROBAND

ELECTRONICS LIMITED

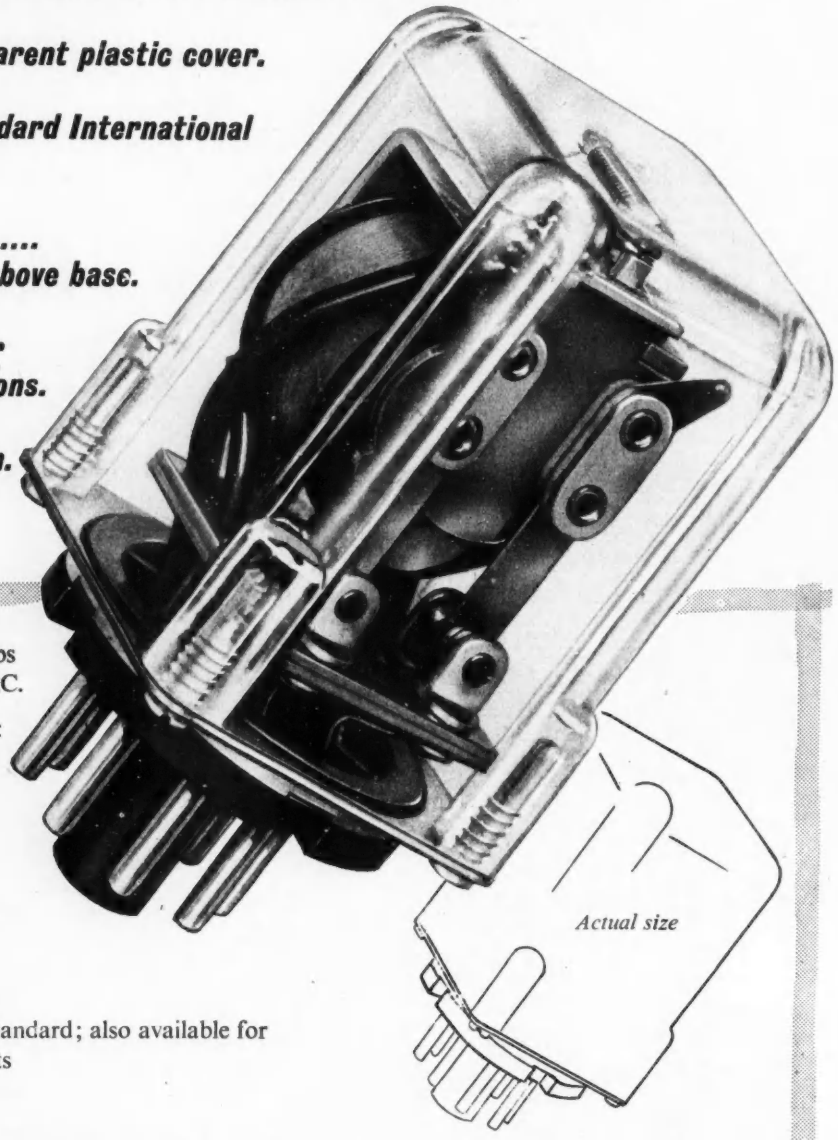
33 Mountgrove Road, Highbury, N.5.

Telephone : CANonbury 4581 & 8581

EE 8116 *for further details*

New... THORN PYGMY POWER RELAY

* ***New interchangeable relay designed for use in remotely controlled automation units. Has double pole changeover contacts.***
* ***Dust proof—transparent plastic cover.***
* ***Plugs into any standard International octal valve base.***
* ***Weight only 4½ ozs .... projection only 2″ above base.***
* ***Mechanical life over 10,000,000 operations.***
* ***Robust construction.***



Actual size

Switching current: 5 amps maximum at 250 volts AC.

Maximum surge current: 10 amps.

Operate time: 8 milliseconds approx.

Release time: 6 milliseconds approx.

Overall dimensions: $1\frac{3}{8}$″ square by $2\frac{9}{32}$″

Coil voltage: 240 volts standard; also available for 6, 12, 24, 48, 60, 110 volts

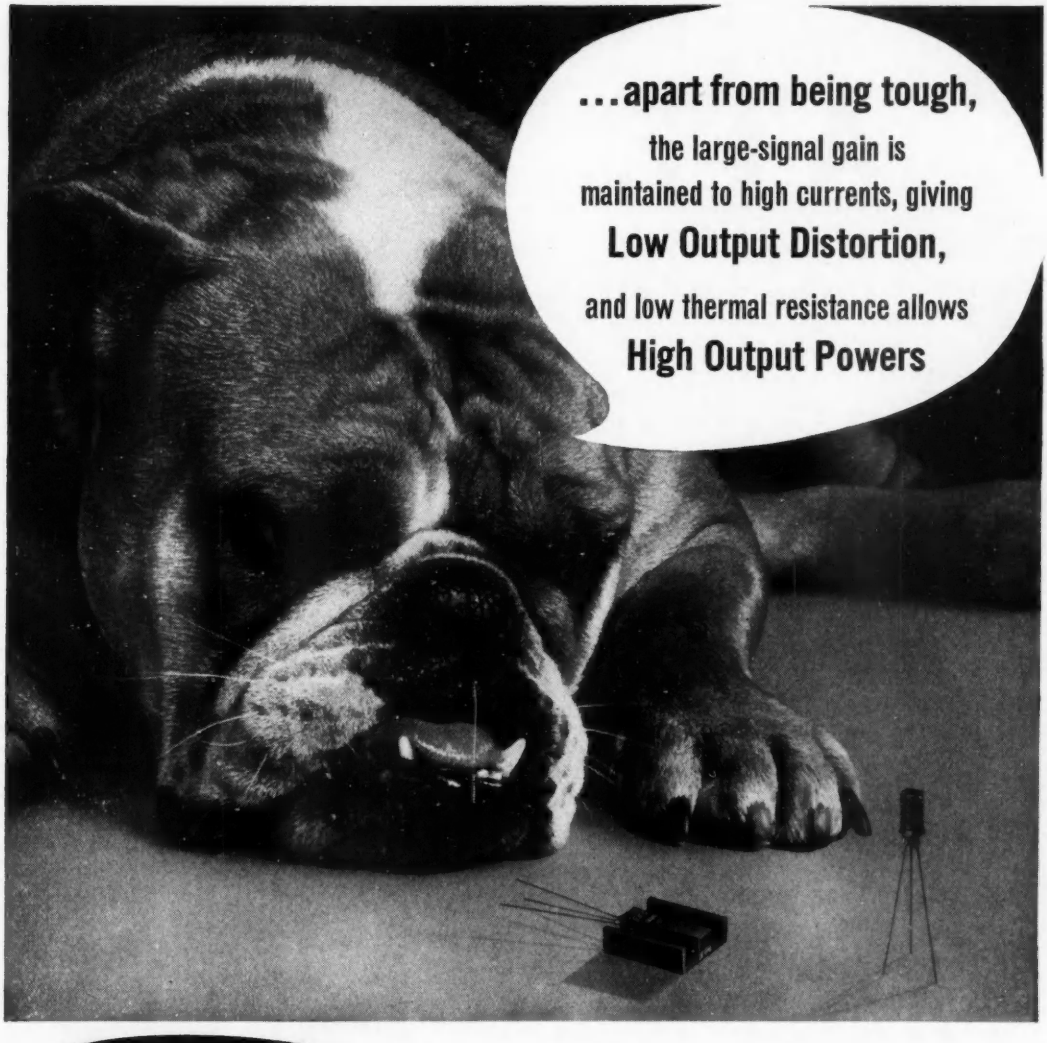
The Thorn Pygmy Power Relay—the most economically priced relay of its type

Thorn

AIRCRAFT COMPONENTS AND CONNECTOR DIVISION

Thorn Electrical Industries Ltd.

Great Cambridge Road, Enfield, Middlesex. *Telephone :* ENField 5353.


...apart from being tough,
the large-signal gain is
maintained to high currents, giving
Low Output Distortion,
and low thermal resistance allows
High Output Powers

G.E.C. Audio Transistors

LOW NOISE Maximum noise factor 5 db (f = 1 kc/s R_g = 500Ω V_{ce} = −2V, I_e = 0.5 mA.)	LOW POWER † Maximum Dissipation at 45°C—200 mW at 55°C—150 mW			MEDIUM POWER † Maximum Dissipation at 45°C—800 mW. at 55°C—600 mW (with 3" × 3" cooling fin)		
MAXIMUM CURRENT 250 mA	MAXIMUM CURRENT 250 mA			MAXIMUM CURRENT 350 mA		
GET 106	GET 114	GET 103	GET 104	GET 115	GET 116	GET 105
V_{ce} max (volts)	15	30*	30	15	30*	40*

* $R_e / R_b > 0.03$ † *Also supplied in matched pairs*

Further details of these and other semi-conductor devices manufactured by the G.E.C. are obtainable from the Semiconductor Division.

Read "Transistor Audio Frequency Amplifiers", written by the staff of G.E.C. Research Laboratories, published by Iliffe & Sons Ltd. Price **21/-**

G.E.C. Semiconductor Division, School St., Hazel Grove, Stockport, Cheshire. Tel: Stepping Hill 3811
or for London Area ring Temple Bar 8000, Extension 10

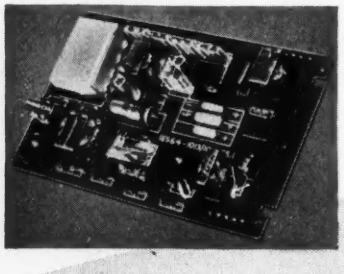
A.T.E introduces–

Transmission Equipment type C.M.

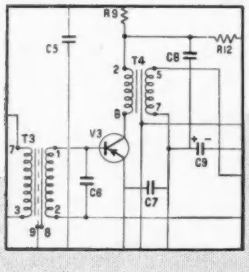
Illustrated is a rackside of telephone channelling equipment for cable or radio systems

- **Fully transistorized**
- **C.C.I.T.T. performance**
- **For existing or new installations**
- **Modern components, methods and design**
- **With inbuilt outband signalling**

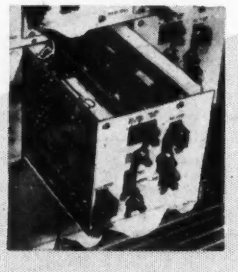
MODERN COMPONENTS



MODERN CIRCUITRY



MODERN MECHANICAL DESIGN



AUTOMATIC TELEPHONE AND ELECTRIC CO. LTD.
STROWGER HOUSE, ARUNDEL ST., LONDON, W.C.2

AT/8021

EE 8119 *for further details*

'ENGLISH ELECTRIC'
'C' CORES

for smaller, lighter transformers and chokes 'ENGLISH ELECTRIC' 'C' type transformer cores are made from high-quality cold-rolled grain oriented silicon steel strip. A wide range of cores is available and these have been developed to meet the exacting standards of the electronic industry, for smaller, lighter and more efficient transformers and chokes.

Some advantages of using 'ENGLISH ELECTRIC' *'C' cores:—*

Easy to store and handle, their use results in reduced assembly time.
Transformers are up to 30% smaller and lighter.
Transformers have lower losses, lower magnetising VA and lower leakage flux.
Cores are suitable for oil-filled, open-type or resin-cast transformers.
Cores are stable up to 250°C.
Cores are available from stock.

full details from

STAND 181
R.E.C.M.F. EXHIBITION
PARK LANE HOUSE, LONDON
APRIL 6th - 9th, 1959

✳

STAND 1329 HALL 11
GERMAN INDUSTRIES FAIR
HANOVER
APRIL 26th - MAY 5th, 1959

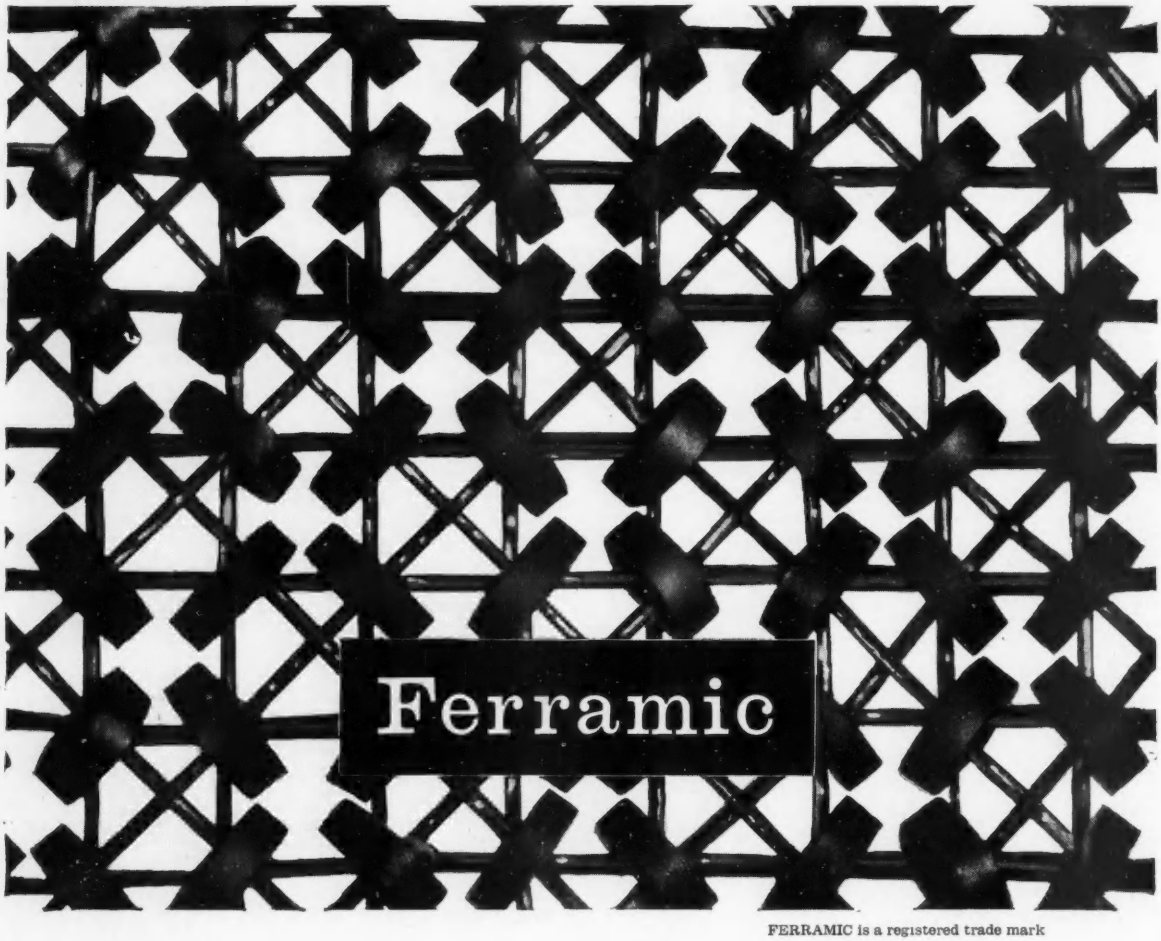
or from

The English Electric Company Limited, Transformer Sales & Contracts Dept.,
East Lancashire Road, Liverpool, 10. Telephone: AINtree 3641

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2.
WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

TFL.39

EE 8120 *for further details*



FERRAMIC is a registered trade mark

A ferrite to remember

Cores made of Plessey 'Ferramic' material, only .050″ in diameter, make possible the intricate memory planes used in modern computer design. The electrical properties of these microscopic cores have to be critically accurate and 'Ferramic' readily meets the demands.

Other grades of 'Ferramic' are also being made in large quantities for many components requiring a core material of the highest efficiency —television transformers, scanning coils and aerial rods among them.

Designers still seeking a core material which will realise the performance they want, at an economical price, are invited to write for data sheets on available grades of 'Ferramic'.

Shown is an enlarged section of a typical Plessey memory plane. Each core is only .050″ in diameter.

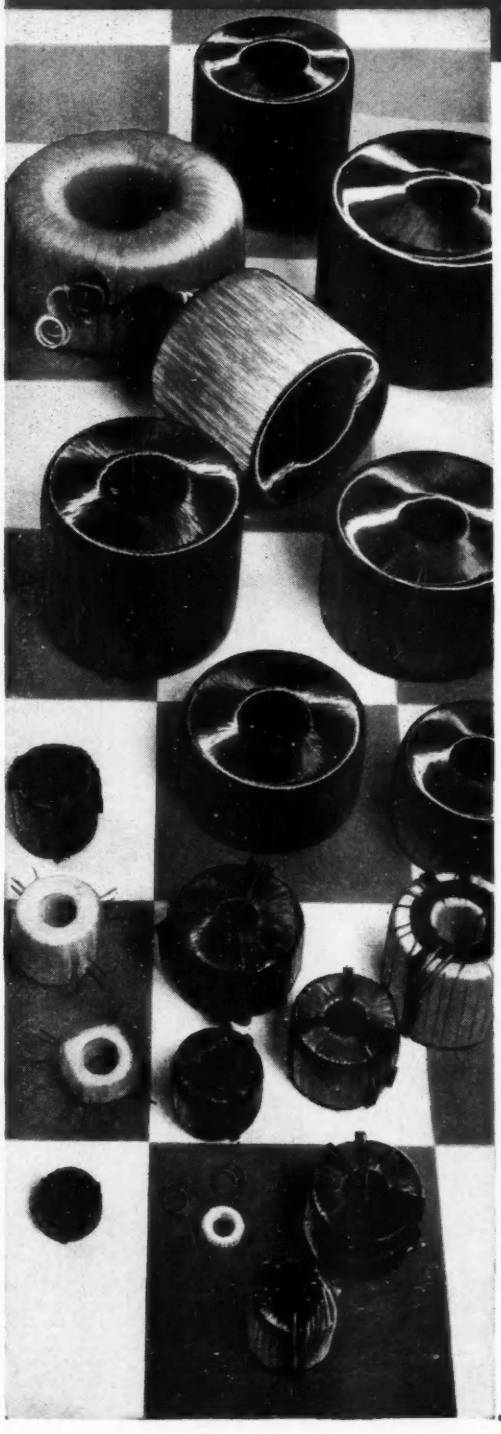
Plessey

CHEMICAL AND METALLURGICAL DIVISION • COMPONENTS GROUP
THE PLESSEY COMPANY LIMITED • WOOD BURCOTE WAY • TOWCESTER
NORTHANTS • TELEPHONE: TOWCESTER 312

Overseas Sales Organisation:
PLESSEY INTERNATIONAL LIMITED • ILFORD ESSEX • TELEPHONE: ILFORD 3040

TC 9

PARMEKO
Toroidal Windings



PARMEKO have been making a lot of toroidal windings on a lot of machines for a long time. Their winding department is among the most versatile in the country. If you're interested in standard or non-standard windings, open or encapsulated with single or stacked cores – see PARMEKO about it.

The applications of PARMEKO toroidal windings are many and varied. Numerous methods of coil construction for both commercial and service-approved applications are available. PARMEKO have designed their own machines to cope with non-standard core sizes and shapes, and are developing equipment for sub-miniature windings. PARMEKO will design to your electrical specification or produce coils to your own winding instructions. The know-how, the facilities, the enthusiasm – they are all there to tackle any problem of toroidal winding.

On the left, a typical selection of toroidal windings.

A SECTION OF THE TOROIDAL WINDING DEPARTMENT

Leaflets giving approximate coil-winding capacities are available from

PARMEKO LIMITED, PERCY ROAD, LEICESTER, ENGLAND

Telephone: Leicester 32287 Telegrams: Parmeko Leicester

SILVERED CERAMIC CONDENSERS

-F.E.C.-

FULHAM ELECTRICAL COMPONENTS LTD.

BEAVOR LANE · HAMMERSMITH · LONDON, W.6. Telephone: RIVerside 4824

Vital to Good Electronics

SILVERED MICA CONDENSERS
-L.E.M.-
L.E.M 100PF ± 5%
L.E.M. 82PF ± 5%
L.E.M 100PF ± 2%
Z124251 L.E.M. 3300PF ± 2%
L.E.M. 25 MFD. ± 20%
L.E.M 500PF ± 2%
L.E.M. 100PF ± 5%
L.E.M. 200PF ± 5%
L.E.M. 1375 mfd ± 1%
LONDON ELECTRICAL MANUFACTURING CO., LTD.
BEAVOR LANE · HAMMERSMITH · LONDON, W.6. Telephone: RIVerside 4824
Backed by 25 years experience

EE 8124 *for further details*

Crofts are showing at the 1959 Engineering Marine Welding and Nuclear Energy Exhibition at Olympia

★

See us on
Stand 4 Row BB
First Floor Empire Hall
16-30th April

NEW PRODUCTS ON SHOW:

The completely new range of Crofts Universal Worm Reduction Gears and Universal Helical Gear Units. The new Crofts 'Ritespeed' Motorised Conveyor Pulley; a self-contained, internally-driven unit. The new 'Croft-Ring' Flexible Resilient Coupling. Crofts Patented Magnetic Clutches and Brakes. The versatile new 'Unidaptor' reduction gear units

CROFTS (ENGINEERS) LTD.
POWER TRANSMISSION ENGINEERS
Head Office: Thornbury, Bradford 3, Yorkshire
Telephone: 65251 (20 lines), 'Crofters Bradford Telex'
Telex 51186

99·9999%

The production of semiconductors and of intermetallic compounds for thermoelectric devices has resulted in a demand for very high purity metals. To meet these developments, The Consolidated Mining & Smelting Co. of Canada Ltd., is producing the following metals to purities of the order of 99·9999%:

BISMUTH · CADMIUM · INDIUM · LEAD · SILVER · ZINC

These "TADANAC" Brand metals are available in the United Kingdom and Europe from

HENRY GARDNER
AND COMPANY LIMITED

2 METAL EXCHANGE BUILDINGS · LEADENHALL AVENUE · LONDON · E.C.3

Telephone: MANsion House 4521

whose Technical Service Department, backed by the full resources of the producers' Research Division, will welcome enquiries.

EE 8124A *for further details*

to keep air moving with the utmost efficiency

PLANNAIR

For thoroughly effective temperature control by the movement of air, design engineers insist on Plannair Blowers—particularly for electronic or aircraft installations where space is at a premium.

Specialist skills and experience explain why Plannair make such a success of making Blowers—consult them from the start and build both their know-how and their Blower right into your equipment.

Certainly if you have—or anticipate—a heating, cooling or ventilation problem, drop Plannair a line or simply ring them; they'll be pleased to give you advice—and specific details about the finest Blowers in the world.

PLANNAIR LIMITED, WINDFIELD HOUSE, EPSOM ROAD, LEATHERHEAD, SURREY · TELEPHONE: LEATHERHEAD 4091

PLA22

Model 3C/FN

A valuable Aid for Industrial Research

—the simultaneous dual-channel recorder

Advances in magnetic tape recording—particularly in the use of twin staggered heads—have aroused considerable interest among many of those engaged in medical, physical, aeronautical and other branches of scientific research. The Ferrograph Series 3C/FN, illustrated here, has been specially developed as the result of close co-operation with research workers in many industrial fields, not only in this country but in laboratories throughout the world.

Besides its normal ability to record and playback time pulses on one track and intelligence on the other, there are many additional applications when comparative measurements, stereophonic sound, or, indeed, any two activities capable of being translated into electrical phenomena (within its frequency and phase shift limitations) can be recorded simultaneously for future study and application. Experience has shown that the scope of such an instrument when used for Research purposes is almost unlimited.

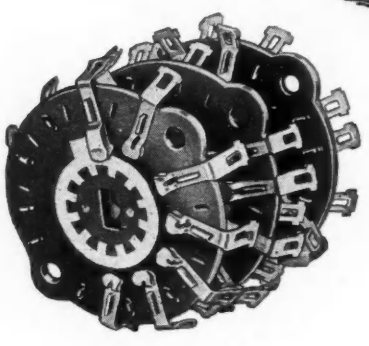
Full specification of Model 3C/FN—which is not for domestic use—available on application. Illustrated leaflet GA 767, describing all other Ferrograph Tape Recorders, will be sent on request.

The Incomparable **Ferrograph**

BRITISH FERROGRAPH RECORDER CO. LTD · 131 Sloane Street · London, S.W.1 · Telephone: SLOane 2214/5 & 1510
(A subsidiary of The Ferrograph Company Ltd.)

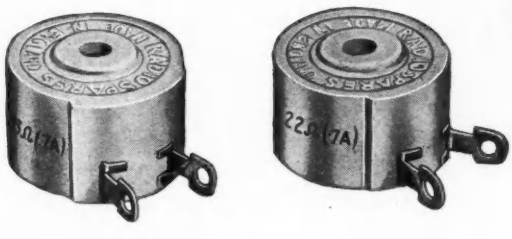
Simplified

★ **REPLACEMENT**
★ **PROTOTYPING**
★ **STOCK CONTROL**



Our "MAKA-SWITCHES" (supplied as separate "Shafting Assemblies", "Spacers", "Mains Switches" and 5 Combinations of "Wafers") enable you to build almost any "Rotary" up to 6 Banks, thus solving all your SWITCHING PROBLEMS!

You can now build almost any Mains Dropper by using our "MAINS DROPPER SECTIONS". Available in a range of 32 Values (2 sizes). Another one of your headaches (especially T/V Droppers) gone!



Full Guarantee
Today's orders despatched today
Trade and industry only supplied

Radiospares Ltd.

4-8 MAPLE STREET · LONDON · W.1 · ENGLAND

Telephone: EUSton 7232-7

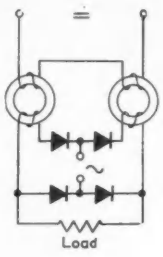
TELEGRAMS: RADOSPERES, WESDO, LONDON *CABLES:* RADOSPERES, LONDON

EE 8128 *for further details*

MAGNETIC AMPLIFIERS

SATURABLE REACTORS

SATURABLE CORE DEVICES



CONSULT

GRESHAM

for :

(*a*) SINGLE-PHASE TRANSDUCTORS AND MAGNETIC AMPLIFIERS
(*b*) THREE-PHASE TRANSDUCTORS AND MAGNETIC AMPLIFIERS
(*c*) HALF-CYCLE RESPONSE TYPES
(*d*) BI-STABLE MAGNETIC AMPLIFIERS
(*e*) RECTIFIER CONTROL
(*f*) STEPLESS POWER CONTROL
(*g*) D.C. MOTOR CONTROL
(*h*) A.C. MOTOR CONTROL
(*i*) VOLTAGE REGULATION
(*j*) MAGNETIC RANDOM PULSE COUNTERS
(*k*) MAGNETIC LOGICAL ELEMENTS

or, in fact, any Saturable Core Application. We have design and manufacturing capacity for these devices ranging in power from milli-watts up to 5,000Kva, and in supply frequency range from 50c.p.s. up to 50,000c.p.s. or higher. Types of construction offered are any of those normally employed in equivalent size transformers. We can undertake the supply of either the individual transductor elements or the development of complete control systems.

Have you a problem where we might be able to assist you?

If so, please write to:—

GRESHAM DEVELOPMENTS LTD

THIRLESTANE HOUSE · 195 UXBRIDGE ROAD

HAMPTON HILL · MIDDLESEX

TELEPHONE MOLESEY 4540, 6211: 3059

Finding relays a puzzle?

We're old hands at straightening out relay problems.

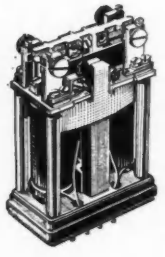
After all, we've been designing and making them for years (over 50 in fact)—big ones, little ones, sensitive ones, general purpose ones; open, dust protected and hermetically sealed, high current, low capacitance, high 'g'—in fact the lot.

We admit that we can't always come up with the answer off the shelf—who can with daily developments in electronics, radar, airborne equipment, nucleonics, reactor instrumentation, etc.? But all of these industries are continually finding Ericsson relays the perfect answer to their problems.

If you are stuck with a very special project and are behind schedule, let us lend you an expert hand.

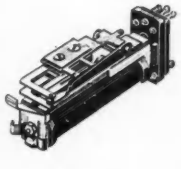
Help us to help *you*—give us as much information as possible, for an early solution.

Here are a few of our current miniatures



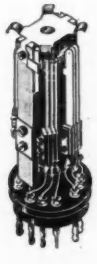
POLARIZED RELAY

Versatile, sensitive and stable. Available with one or two change-over contacts. Dust cover or hermetically sealed. Long or short frame models.



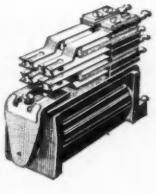
TYPE 1A RELAY

Highly sensitive—non-polarized type with balanced moving system for high 'g' performance. Hermetically sealed. With one change-over.



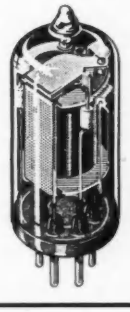
TYPE 2 RELAY

General purpose type with balanced moving system. Normal and heavy duty contacts up to 4 change-overs. Hermetically sealed.



G.P. RELAY

For general purpose applications. Multi-contacts up to 4 units. Open, dust cover or hermetically sealed with normal, heavy duty or low capacitance contacts.



MGL RELAY

Specially designed for electronic and nucleonic applications. One change-over contact. Fits B7G base. Also available with metal can.

Full details of these and other relays can be obtained from:

ELECTRO-MECHANICAL DIVISION
BEESTON · NOTTINGHAM · ENGLAND

ERICSSON

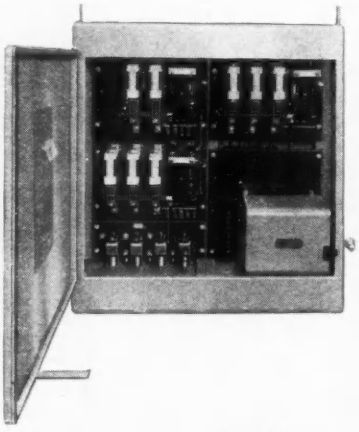
Ericsson Telephones Limited
Head Office: 22 Lincoln's Inn Fields
London, W.C.2. Tel. HOLborn 6936

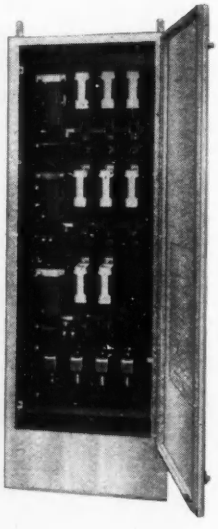
E107-85

EE 8130 *for further details*

"Start"

with DONOVAN automatic star-delta starters





Although Donovan make highly complex control panels for most exacting demands of modern industry, where the advantage of automation and automatic control are becoming universally appreciated, the same sound engineering and reliable design is incorporated in single starters of simple types such as the ones illustrated.

The Donovan Size 4 Star-Delta Starter illustrated with isolator (top) and without isolator (bottom), incorporates the following features;—

Full switching by the use of three contactors.

The Star and Delta contactors are both mechanically and electrically interlocked.

Robust silicone-fluid dash-pot timer for reliable operation.

Starter is designed to comply with B.S. 587 (1957) for "Severe" mechanical duty class and "Frequent" operational duty. In addition, the contactors used in these starters have been designed and tested in accordance with B.S. 775 (1956).

For further details, write for Type A44 leaflets

THE DONOVAN ELECTRICAL CO. LTD.

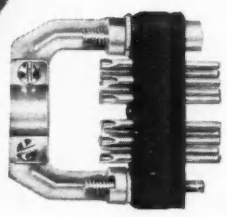
78-82 GRANVILLE STREET · BIRMINGHAM 1

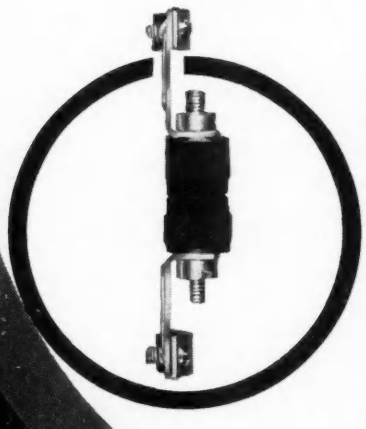
LONDON DEPOT: 143-151 YORK WAY, N.7 GLASGOW DEPOT: 25 PITT ST. C.2

Sales Engineers available in LONDON, BIRMINGHAM MANCHESTER: GLASGOW, BELFAST, BOURNEMOUTH

EE 8131 *for further details*

a firm GRIP on complex connection





From their wide selection of plugs and sockets, MODAC offer a standard range of rectangular and circular miniature connectors, to which is soon to be added a sub-miniature range with combinations of 10, 16, 28 and 34 contacts.

The main feature of this advanced design is the independently sprung, multi-point contact which provides self-cleaning, low contact resistance and is ideal under conditions of vibration.

MODAC is equipped for the design of connectors to customers' specifications and to supply any of their range as cable assemblies.

They are more than willing—at any time—to come to grips with your general wiring problems.

Modac miniature and sub-miniature connectors

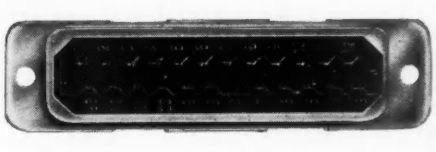
'Modac' is a Registered Trade Mark

for further information and a copy of the 'Modac' catalogue, please contact:

Modern Acoustics Limited
Contact Connectors Division

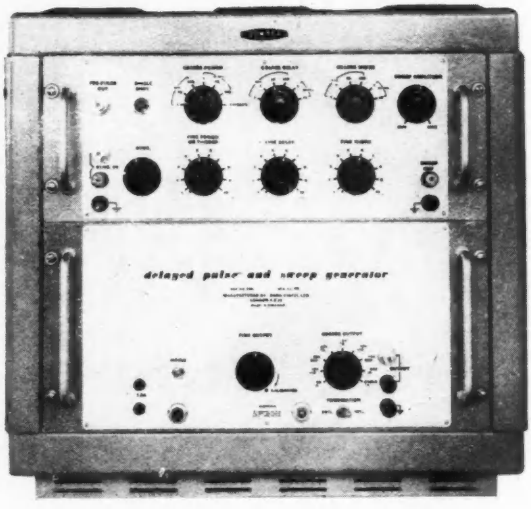
MANOR WAY · BOREHAM WOOD · HERTS · ELSTREE 3636

Agents for British Commonwealth Countries: Plessey International Limited · Ilford · Essex · Ilford 3040



MAL 2

DELAYED PULSE AND SWEEP GENERATOR



A versatile pulse generator designed to meet the need for a comprehensive instrument covering a wide range of pulse work. Four main facilities are provided: a pre-pulse, a main pulse delayed on the pre-pulse, a negative going sawtooth and a fast rising pulse formed from a pure line.

BRIEF SPECIFICATION

Period

Continuously variable from 0·9μsec to 1·05sec i.e. 0·95c/s to 1·1Mc/s. Accuracy ±5%.

Pre-pulse

40mμsec. 8V peak in 75Ω, positive going.

Main pulse

Width: Variable from 0·09μsec to 105msec ±5%.

Amplitude: Control gives 4:1 attenuation of each of four maximum outputs as follows:

5V max in	75Ω	rise time 10mμsec
10V max in	150Ω	rise time <20mμsec
25V max in	600Ω	rise time <40mμsec
50V max in	1000Ω	rise time 50mμsec

Polarity: Positive or negative going.

Accuracy: ±2%.

Delay

Conclusion of pre-pulse to advent of main pulse, delay variable from 0·09μsec to 105msec. Accuracy ±5%.

Sweep

D.C. coupled negative going sawtooth same width and delay as main pulse.
15V peak max.

Cable pulse

Obtained from short circuited pure line.
One positive and one negative going pulse coincident with main pulse.
25mμsec wide 3V max in 75Ω, rise time <8mμsec.

Sync, trigger or single shot facilities provided.
Full data available on request.

CINTEL

RANK CINTEL LIMITED
WORSLEY BRIDGE ROAD · LONDON · SE26
HITHER GREEN 4600

Sales and Servicing Agents: Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow.
McKellen Automation Ltd 122 Seymour Grove, Old Trafford, Manchester, 16. Hawnt & Co., Ltd., 59 Moor St., Birmingham, 4.

NEW

Silicon alloy transistors with low 'bottoming' voltage

SILICON

OC200 The OC200 is the first of a new range of silicon alloy transistors now being introduced by Mullard. This range has all the advantages of the well-known OC70 germanium series *plus* the silicon features of low collector leakage and high permissible operating temperature.

This duplication of the essential properties of the OC70 series—*including a low "bottoming" voltage*—enables designers to gain the maximum benefit from their experience with germanium transistors when using the new silicon types.

The wide junction temperature rating of these new transistors makes them suitable for use at high temperatures in aircraft, guided weapons and industrial equipment. This feature is exemplified by the OC200 which has a junction temperature rating of -55 to +150°C with minimum α' (or β) controlled to a limit of 10 at -55°C and 15 at room temperature.

The maximum collector voltage of type OC200 is 25V, but due to its low "bottoming" point it may be operated from supplies as low as 1.2V. The linearity of current gain with collector current is well maintained up to 50mA.

Like the OC70, the OC200 is well suited for use in pre-amplifier circuits. Its noise figure is, in fact, better than that of the germanium transistor. Write on your company notepaper to the address below for complete data.

ABRIDGED DATA

SILICON P-N-P ALLOY JUNCTION TRANSISTOR OC200

$T_{junction}$	-55 to +150°C
V_{cb}(pk) max.	-25 V
v_{cb} max. (av. or d.c.)	-25 V
i_c (pk) max.	50 mA
I_c max.	15 mA
α' (or β) spread	15 to 60
Guaranteed min. α' (or β) at -50°C	10
Bottoming Voltage (I_C=7mA)	130 mV
Average noise figure	8 dB
$r_{bb'}$	125 ohms.

Mullard

semiconductor division

Mullard Limited · Semiconductor Division

Mullard House · Torrington Place

London · W.C.1 · Telephone: Langham 6633

AND NOW!

TO THE MOST ACCURATE AND EXTENSIVE RANGE OF WIREWOUND POTENTIOMETERS IN THE WORLD

COLVERN

ARE PROUD TO ANNOUNCE

THE ADDITION OF THE TYPE CLR 23/00 — DESIGNED TO MEET INSTRUMENT MANUFACTURERS REQUIREMENTS FOR A MULTI-TURN PRECISION POTENTIOMETER AT A LOW COST.

BRIEF SPECIFICATION

Rating 4 watts

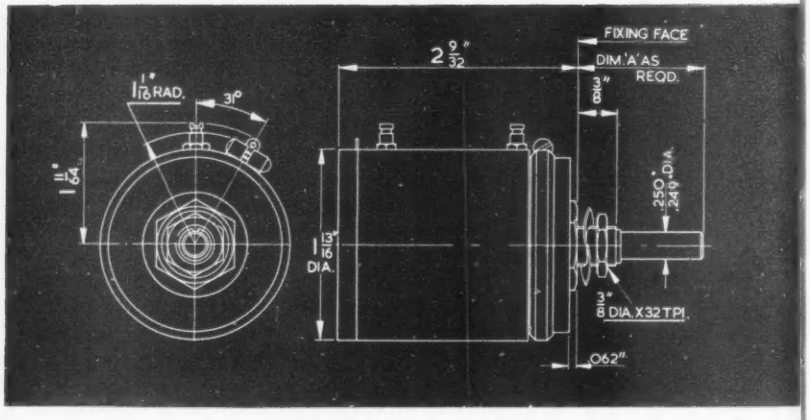
Resistance range 100Ω to 250,000Ω

Resistance tolerance standard ±5%

Independent linear accuracy standard ±0.5%

Max. working volts spindle/track 1,000 VDC

Tapping points can be provided



TURNS INDICATING DIALS

A49—10 turn
A559—15 turn

10 and 15 Turn Dials with accuracies of 1 part in 1,000, and 1 in 1,500 respectively, aluminium body finished satin chrome colour with large diameter silver anodised clear reading scale.

Quick change turns indicator avoids ambiguity.

Secured to panel by component bush and nut, knob fastening directly to shaft eliminates backlash.

ALSO AVAILABLE WITH FRICTION LOCKING

SEE US AT

STAND NO. 52

R.E.C.M.F.

COMPONENT

EXHIBITION

GROSVENOR HOUSE

APRIL 6th to 9th

COLVERN 'CAMPOTS' THE MOST ACCURATE IN THE WORLD

COLVERN LTD., SPRING GDNS., ROMFORD, ESSEX, ENGLAND

See us at the
R.E.C.M.F. EXHIBITION
APRIL 4-9
Stands 167 and 169

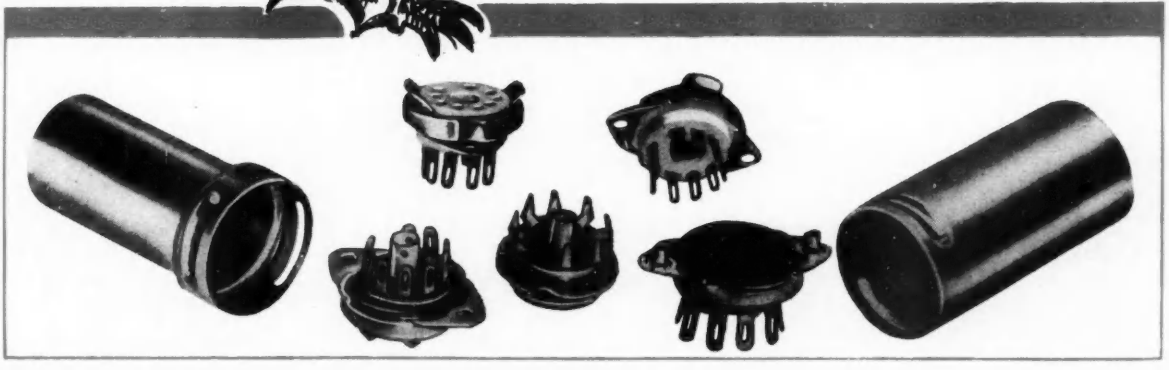
Something to crow about!

. . . from morning till night the Brayhead Valveholders are something which really make us justifiably proud. Many types have been designed to suit all needs, and with printed circuits in mind they have proved completely versatile and competitive in price without falling from the very highest level of efficiency. These are some of the features which put the Brayhead B9A Valveholder way out in front.

- Free-seating contacts (prevents damage to valves).
- Removable and replaceable contacts (no chance of solder running into contacts).
- Contact soldering to chassis if required.
- Wedge and spring locking action of can to saddle (no 'rock' or earthing noise).

With body moulded in ceramic or phenolic material with extremely low-loss properties and screening cans in all standard sizes and finishes, the Brayhead B9A Valveholders are unsurpassed in design and construction.

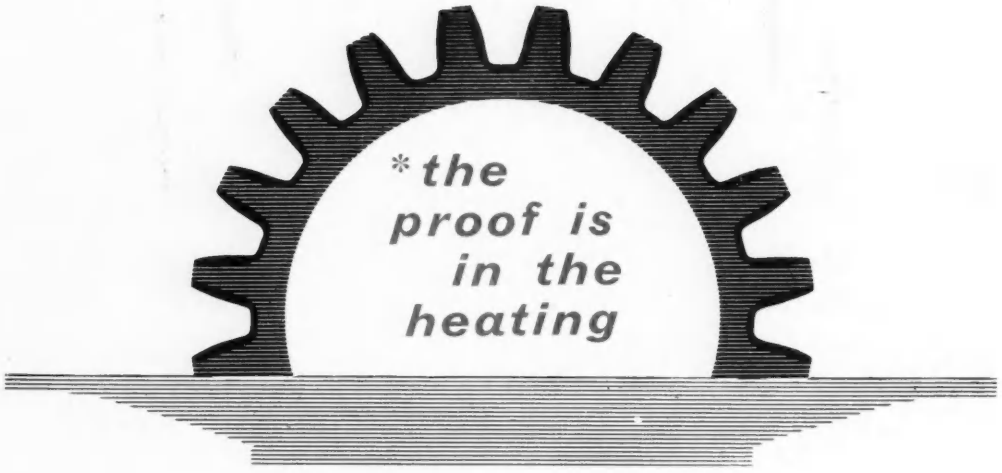
Write for full details and descriptive leaflet



BRAYHEAD (ASCOT) LTD.

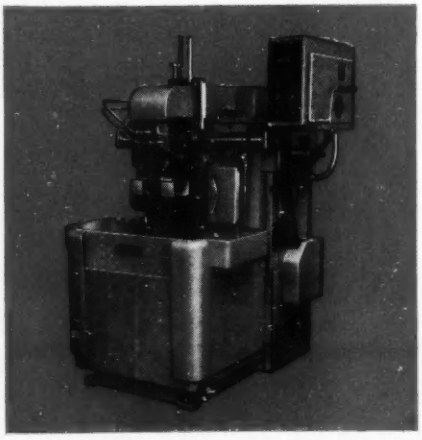
FULL VIEW WORKS KENNEL RIDE • ASCOT • BERKS • Tel: Winkfield Row 427/8, or Ascot 1907/8/9 Grams: Brayhead Ascot

B34



* A demonstration is the best method of proving to your satisfaction the suitability of Delapena Induction Heating equipment for your own specific needs.

With this in mind our unique Applications Department offers you demonstrations of the many advantages of our patented induction heating process. For example, gear hardening can be made a production line process; manufacturing costs can be reduced by the elimination of expensive grinding operations; tooth profile can be finally hardened with the minimum of tooth "shape-change", ensuring a quieter and longer-lasting gear. These are but a few of the advantages offered to you by Delapena Heat Induction equipment. Why not come and see for yourself? We'll prove it!



This fully automatic machine handles gears within a range of 1½" to 26" diameter, 2 to 10 diametrical pitch, face widths up to 8", and spur and helical gears up to 30°.

Delapena ***induction heating***

DELAPENA & SON LIMITED

Manufacturers of Induction Heating and Precision Honing Equipment

ZONA WORKS · CHELTENHAM · ENGLAND

Telephone: CHELTENHAM 56341

Ersin Multicore

As usual we are at the R.E.C.M.F. Exhibition, Grosvenor House

means solder at its best!

When the job depends on solder, most leading television, radio, telephone and electronic equipment manufacturers prefer to use Ersin Multicore. They know that Ersin Multicore Solder makes precision soldering quicker and more economical.
Ersin Flux is a high grade rosin which has been chemically processed to increase its fluxing action — while still retaining its non-corrosive properties.
And Ersin Multicore Savbit Type 1 Alloy prolongs the life of soldering irons up to ten times!
Use Savbit . . . and save money.

SAVBIT FOR FACTORIES

Ersin Multicore Savbit Type 1 alloy containing 5 Cores of non-corrosive flux is supplied to factories at bulk prices on 7lb. reels. 16 and 18 s.w.g. are the diameters most suitable for the majority of soldering processes. Supplies are also available on 1lb. reels.

SAVBIT FOR THE SMALL USER

The size 1 Carton contains approximately 53 ft. of 18 s.w.g. SAVBIT. It is also supplied in 14 s.w.g. and 16 s.w.g. Obtainable from radio and electr cal stores. Ersin Multicore 5-Core Solder is also supplied in 4 specifications of Standard Tin/Lead alloys.
Price 5/- each (subject).

SAVBIT FOR THE SERVICE ENGINEER

Approx. 170 ft. of 18 s.w.g. SAVBIT is supplied on a 1 lb. reel packed in a carton. Price 15/- each (subject).

SPECIAL HIGH AND LOW MELTING POINT SOLDERS

Comsol .... (Melting point 296°C)
P.T. ..... (Melting point 232°C)
L.M.P. .... (Melting point 179°C)
T.L.C. .... (Melting point 145°C)

STANDARD TIN/LEAD ALLOYS

Ersin Multicore 5-core Solder is available in the following standard alloys:

60/40, 50/50, 45/55, 40/60, 30/70, and 20/80 and in 9 gauges on 7 lb. and 1 lb. reels.

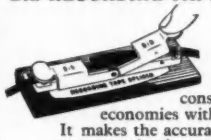
HOME CONSTRUCTOR'S 2/6 PACK

Now available containing alternative specifications: 19 ft. of 18 s.w.g. 60/40 alloy or, for soldering printed circuits, 40 ft. of 22 s.w.g. 60/40 alloy. Both wound on Reels. 2/6 each (subject).

Bib WIRE STRIPPER & CUTTER

This 3 in 1 tool strips insulation without nicking the wire, cuts wire cleanly and splits plastic extruded twin flex. Adjustable to most wire thicknesses. 3/6 each (subject).

Bib RECORDING TAPE SPLICER



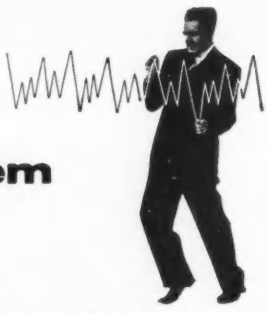
Recording enthusiasts can effect considerable tape economies with this splicer. It makes the accurate jointing of tape so simple and quick that every scrap can be used. 18/6 each (subject).

A free copy of an interesting article "How to Edit Tape Recordings" will be sent you if you will kindly send us a stamped addressed envelope.

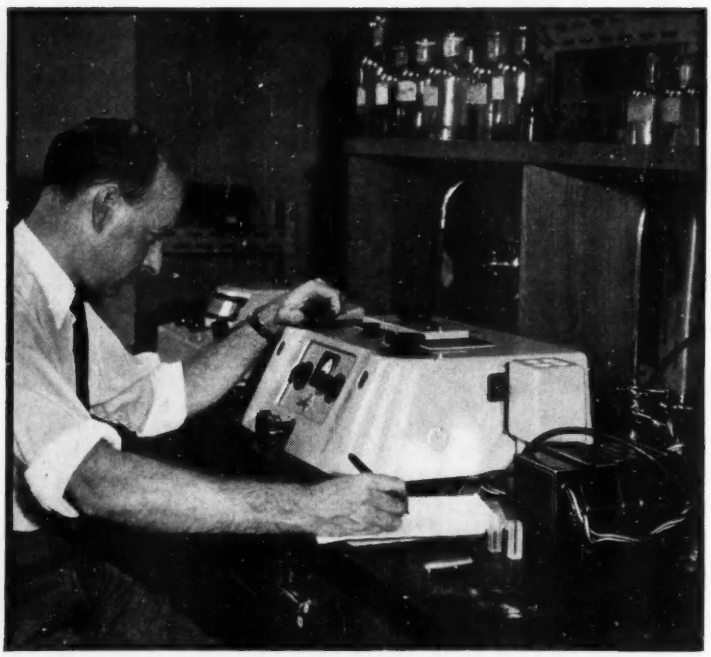
MULTICORE SOLDERS LIMITED, MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. (BOXMOOR 3636)

EE 8138 *for further details*

C V T



A Mains Voltage Fluctuation problem



A Unicam type S.P. 600 Spectrophotometer in use with an 'Advance' C.V.T.

in Absorption Analysis

The Spectrophotometer employs a particular optical/electronic system in which a light source, photocells and special amplifier play a vital part. Vital, because it is upon their correct performance characteristics that the accuracy of the instrument depends.

But their correct performance, in turn depends upon a stable supply voltage. How is this achieved?

. . . straightened out by

In the Unicam S.P. 600 Spectrophotometer illustrated, the tungsten lamp and valve heaters in the amplifier are supplied from the mains through an 'Advance' Constant Voltage Transformer (seen on the right of photograph). As a result the accuracy of the instrument is unaffected by fluctuating supply voltage.

'Advance' Constant Voltage Transformers provide a.c. voltage stabilization of ± 1% for input variations of up to ± 15% at maximum load. For power requirements from 4 to 6,000 watts, they are automatic and contain no moving parts.

Advance

CONSTANT VOLTAGE TRANSFORMERS

"VOLTAGE STABILIZATION"

This 'Advance' Booklet gives authoritative information on 'Advance' Constant Voltage Transformers, and the service available to deal with your particular voltage fluctuation problems. Send for a copy.

POST THIS COUPON TO-DAY

To ADVANCE COMPONENTS LIMITED, ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX.

Please send me a copy of your booklet "Voltage Stabilization by Advance"

NAME .....

POSITION .....

COMPANY .....

ADDRESS .....

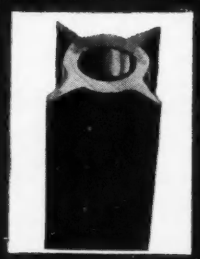
..... M13

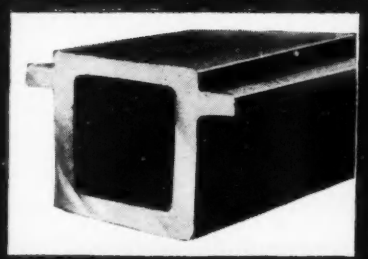
GD 13 Advance COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444

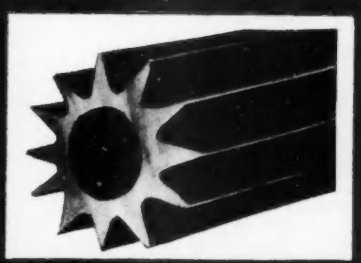
"and he said (that's the Managing Director) 'we must cut down machining costs Jones' (that's me) so I said well why not use

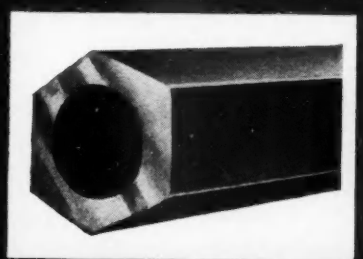
STEEL EXTRUSIONS

Then he said 'do you mean those things made by Low Moor'? . . . and I said yes . . . and he asked me how they would help machining costs, so I told him, and he simply said 'by jove, we'll ring them straight away' "









LOW MOOR
FINE STEELS LIMITED

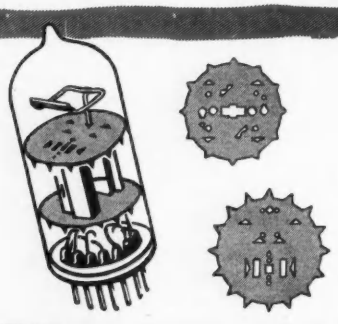
EE 8140 *for further details*

For Electrical Insulation

in all its forms... Delanco REGD. Electrical Insulation

A complete electrical insulation service is offered by the DELANCO Organization to overseas buyers. Materials include paper and linen based bakelite sheet, rod and tube. Vulcanized fibre, presspahn, bakelite tube, copper clad bakelite for printed circuitry, and components machine stamped and formed in all these materials.

Our mica division can offer excellent service and finest quality workmanship from tools made in our own tool rooms.

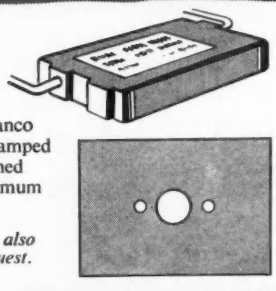


RADIO VALVES

Bridges and separators in all grades of mica, precision machined to tolerances of down to .0001 inch or plus and minus 2 microns.

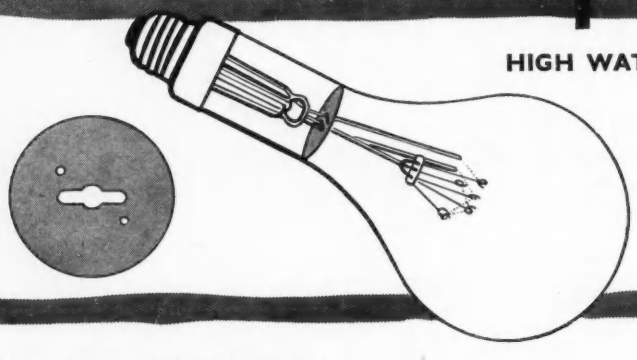
A quality control and inspection department ensures highest degree of accuracy and quality before despatch.

CAPACITOR MICAS



These are made in many grades of Delanco pure mica and are stamped from specially designed tools to ensure maximum accuracy.

Samples of these are also available free on request.



HIGH WATTAGE LAMPS

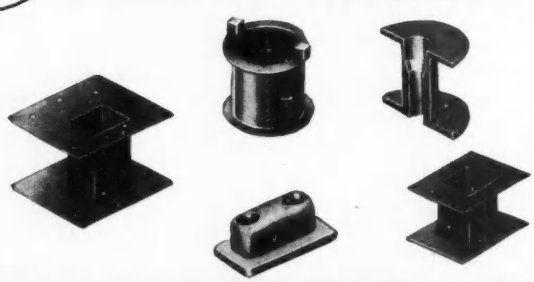
Lamp discs made from many grades of mica to suit all types of lamps. Again close tolerances and quality control ensure accuracy and finish to highest standards. All tools made in our own extensive tool rooms.

Samples and technical data are free. Ask for DELANCO MICA INFORMATION FOLDER.

HIGH HEAT COMPONENTS

We are currently producing bobbins and other components in high heat resisting materials, capable of working at temperatures in excess of 250° Centigrade. Samples and technical data available on request.

The DELANCO insulation materials catalogue covering all insulation materials will be sent on receipt of your instructions.



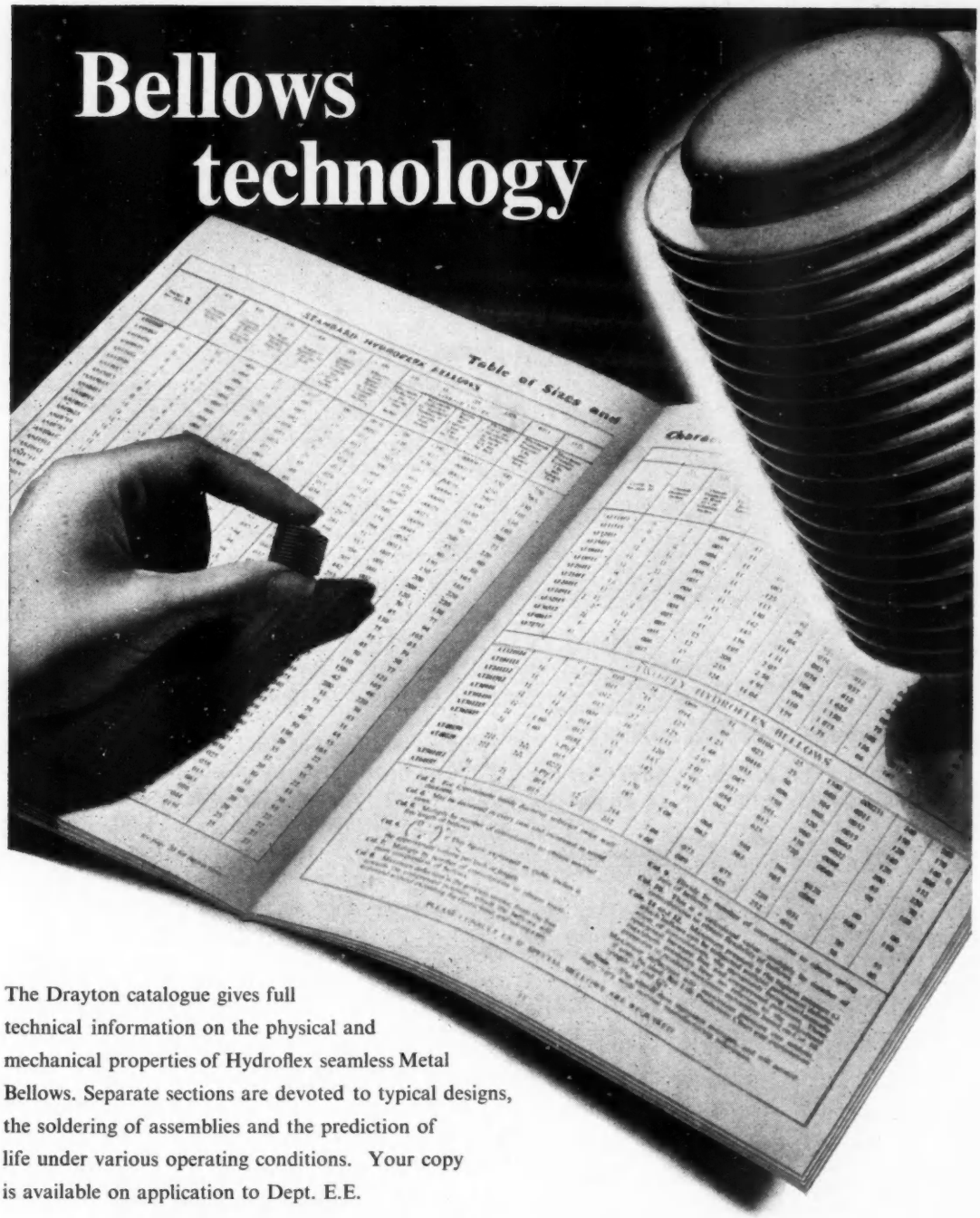
Anglo-American Vulcanized Fibre Co. Ltd

CAYTON WORKS BATH STREET LONDON E.C.1. CLE 3271 Grams: PROMPSERV AVE, LONDON

DELANCO WORKS • LEONARD STREET • LONDON E.C.2

VULCANIZED FIBRE · LAMINATED BAKELITE · LEATHEROID · MICA · COMPOSITE INSULATIONS · EBONITE · PRESSBOARD
PRESSPAHN · CLOTHS, TAPES AND SLEEVINGS · PRESSED, TURNED AND MACHINED COMPONENTS

Bellows technology



The Drayton catalogue gives full technical information on the physical and mechanical properties of Hydroflex seamless Metal Bellows. Separate sections are devoted to typical designs, the soldering of assemblies and the prediction of life under various operating conditions. Your copy is available on application to Dept. E.E.

HYDROFLEX

seamless Metal Bellows

HYDROFLEX

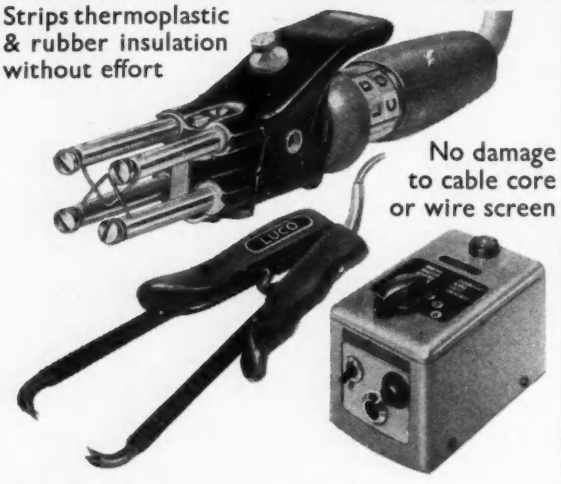
B26

DRAYTON REGULATOR & INSTRUMENT CO. LTD., WEST DRAYTON, MIDDLESEX. *West Drayton 4012*

EE 8142 *for further details*

LUCO ELECTRICALLY HEATED Wire Strippers

Strips thermoplastic & rubber insulation without effort



No damage to cable core or wire screen

ERSA Soldering Appliances

Minitype SOLDERING NEEDLES with screwed-in elements; 10, 20, 30 W., for finest electronic work

SOLDERING PENCILS 20, 30, 50W., for the Assembly Line and the Service Engineer

Also available, SOLDERING BATHS for Printed Circuits and for the Tinning of Enamelled Wire

WTC Comprehensive Tool Range for Electric, Electronic and Allied Industries

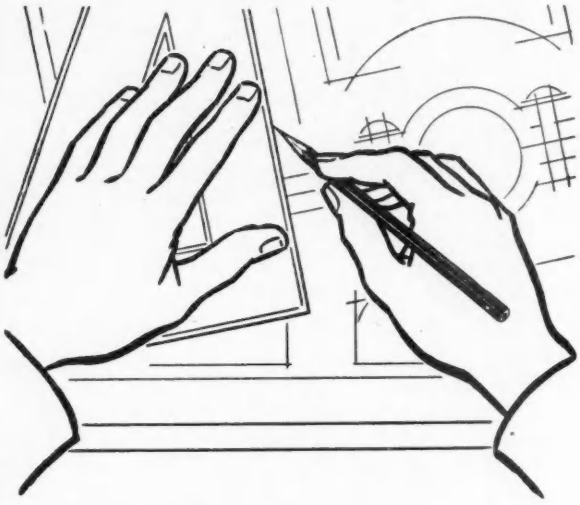
Box Joint Wiring Pliers, Sidecutting and Frontcutting Nippers, 4½"-8".
Special Pliers for tipcutting, securing circlips and thermo-shunting.
Printed Circuit Pliers for crimping and cutting, bending and cutting.
Wirestrippers, hand and bench type.
Inner Core Ejectors for screened cables.
Chrome-Vanadium Box Spanner and Screwdrivers, also with flexible shaft.
Torque Wrenches and Torque Screwdrivers.
Standard Piercing Punches, Ejector Pins, Locating Pins.
Spring Tension Pins, Bushes, Sleeves, Bolts.
Hard Needle Files, Diamond Files, Laps and Wheels.

Apply for Catalogues EEI

WELWYN TOOL Co. Ltd.

Stonehills House
WELWYN GARDEN CITY · HERTS
Phone: Welwyn Garden 5403-4

EE 8143 *for further details*



"To a chap like me – and I'm proud of my work – my pencil's my living.
The pencils I use have to stand up to fast hard work, their grading's got to be absolutely spot on – not almost or nearly but bang on the dot every time.
The leads must hold their points and flow smoothly throughout a long line – no crumbling or 'clinkers' mark you! – and if I erase a line it must go cleanly – there's no 'furrow' left in my paper so you won't find ghost lines in prints made off my drawings. As a matter of fact you can tell from a print when it is my drawing – the print's always first class."

"What pencils do I use?"

"Venus drawing pencils of course, the ones with the crackle finish! – how else do you think I keep up my high standard?"

VENUS DRAWING PENCILS

* VENUS *Drawing Pencils are made in 17 accurate grades from 9H to 6B.*

THE VENUS PENCIL CO., LTD., LOWER CLAPTON ROAD, LONDON E.5

Terminettes patents pending

The Lead-Through and Stand-Off Terminals with Poly-Tetra-Fluoro-Ethylene (Fluon/Teflon) Insulators and silver-plated Conductors.

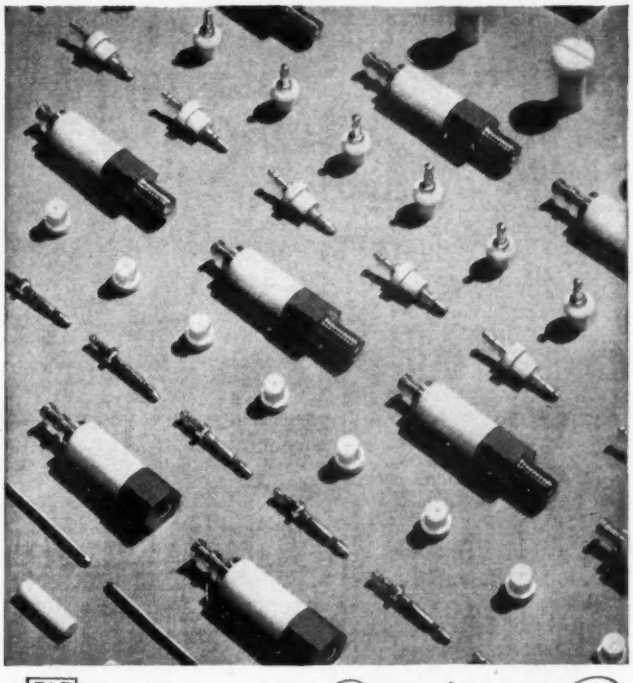
Terminettes

are SELF-SEALING, SELF-FIXING

withstanding vibration at 20 G at 1,500 cycles; are moisture-repellent and have high insulation—from 3,000 to 25,000 volts according to size—a working range of temperatures from −80° C. to +300° C. and are available in 30 different standard types, each type in 9 different colours.

Terminettes *are*

the World's most economical Terminals, made and guaranteed by



Henry and Thomas Ltd

YEO STREET, BOW COMMON, LONDON, E.3

PIRTOID

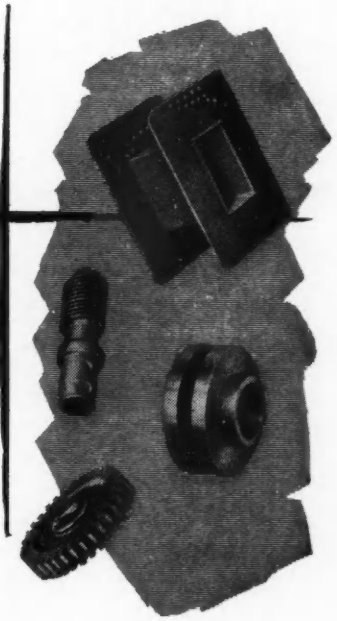
SYNTHETIC RESIN BONDED LAMINATE

brings you

MATERIAL SOLUTIONS

to your

CURRENT PROBLEMS



. . . because the range of PIRTOID Paper and Fabric base laminates affords all the machining qualities needed with consistent uniform dielectric and mechanical strength. Read this booklet, sent gladly on request.

H. CLARKE & CO. (MANCHESTER) LTD

Atlas Works · Patricroft · Manchester

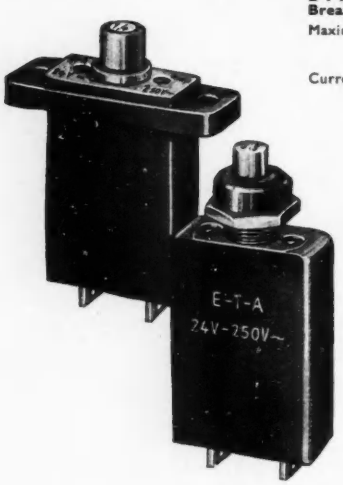
Telephone Nos. ECCLES 5301-2-3-4-5

dm CK4

Protect your Equipment with these Important New Components

E-T-A

CURRENT OVERLOAD PROTECTION



E-T-A Thermal Overcurrent Breakers.

Maximum Voltage Rating
250 V. A.C.,
24 V. D.C.

Current Range
Minimum 0.05 Amps.
Maximum 25 Amps.

A precision built miniature breaker which will absorb surge currents and protect circuits at rated currents. An extremely wide range of ratings are available, as well as various designs, including auxiliary circuit and dual voltage connections.

See our catalogue section 1/52.

E-T-A Thermo Magnetic Overcurrent Breakers.

Maximum Voltage Rating
250 V. A.C.,
65 V. D.C.

Current Range
Minimum 0.05 Amps.
Maximum 15 Amps.

This extremely compact unit offers protection against the whole range of possible fault conditions and instantaneously trips short circuit currents. Can be supplied with auxiliary circuit and dual voltage connections.

See our catalogue 2/57.

The above units are suitable for use with electronic equipment, telecommunications, small transformers, rectifiers, fractional H.P. motors, domestic appliances, etc. and are only part of our wide range of low voltage D.C., single phase A.C. and 3 phase breakers. We also supply starter winding switches, snap action motor protection relays, thermal cut-outs, etc.

Please write to us for our catalogues or any technical information you may require with regard to your own circuit protection problems.

TECHNA (SALES) LTD

47 WHITEHALL, LONDON, S.W.I.

Telephone : Whitehall 1348/9

AUTOMATIC PRECISION

by **Ketay**

THE KETAY RANGE of servo mechanisms meets every requirement of industry and the Armed Services and includes the following :—

SYNCHROS *Control Transmitter, Control Transformer, Control Differential*
Torque Transmitter, Torque Receiver, Torque Differential

RESOLVERS, TACHOMETER GENERATORS, SERVO MOTORS, GEAR HEADS, MAGNETIC AND TRANSISTORISED AMPLIFIERS

Type Approval—
Ketay Synchros

Ketay size 15 synchro range has received type approval from the Ministry of Supply.

M.O.S. and A.R.B. Design Approved

The majority of these units are available for early delivery and are manufactured to N.A.T.O. and M.O.S. specifications.

Servo Systems

The design, development and production of all types of Servo Systems for aircraft and industrial use is undertaken by Ketay Limited, and our Representative will be pleased to call and discuss your requirements.

KETAY LIMITED · Eddes House · Eastern Avenue West
Romford · Essex · Telephone : Seven Kings 6050

K4

EE 8148 *for further details*

THIS PHOTOGRAPH
is reproduced by courtesy of
MULLARD LTD.

and shews the clean lay-out employed by this organisation.

Welding techniques are the key to the phenomenally high production rates associated with extremely low shrinkages that are achieved.

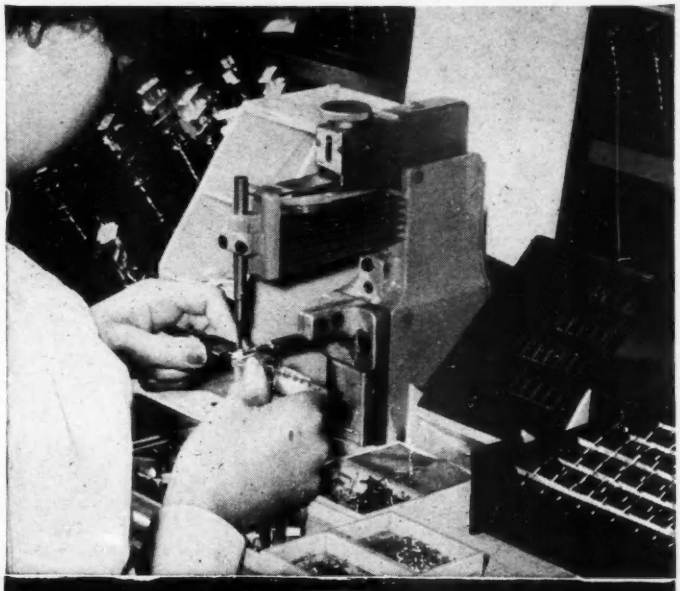
THE SLEE WELDER

illustrated here is type "RK2" which is unique in that it combines High Speed accurate welding with the minimum of effort and skill on the part of the operator. The frictionless electrode system precisely controls, apart from positioning, the structure throughout every phase of the complex welding cycle.

Practically every known metal and alloy is now being welded on these machines which are obtainable up to 75 KVA. They represent the ultimate in precision welding.

OTHER PRODUCTS

ELECTRONIC TIMING GEAR. PROCESS CONTROLLERS, MAGNETISING EQUIPMENT. HIGH SPEED RELAYS AND CONTACTORS, ETC.



SLEE LONDON

SOUTH LONDON ELECTRICAL EQUIPMENT COMPANY LTD.

LANIER WORKS, HITHER GREEN LANE, LONDON, S.E. 13. LEE GREEN 4814 5 6.

The **QUICKER** *answer to your* **SPECIAL** ***INSTRUMENTATION PROBLEM!***

Within 10 to 14 days of putting your problem to M.I.P. you can be testing the prototype of your special 'custom-built' instrument. That is the time we at M.I.P. regard as reasonable to find the answer to the 'special' instrumentation prob em.

- **SPECIAL RANGES AND SCALES**
- **NON-STANDARD INSTRUMENTS**
- **MULTI-RANGE TEST SETS**
- **SPECIAL APPLICATION COMPONENTS AND CONTROL GEAR**
- **DESIGN DEVELOPMENT**
- **PRODUCTION REPAIRS**

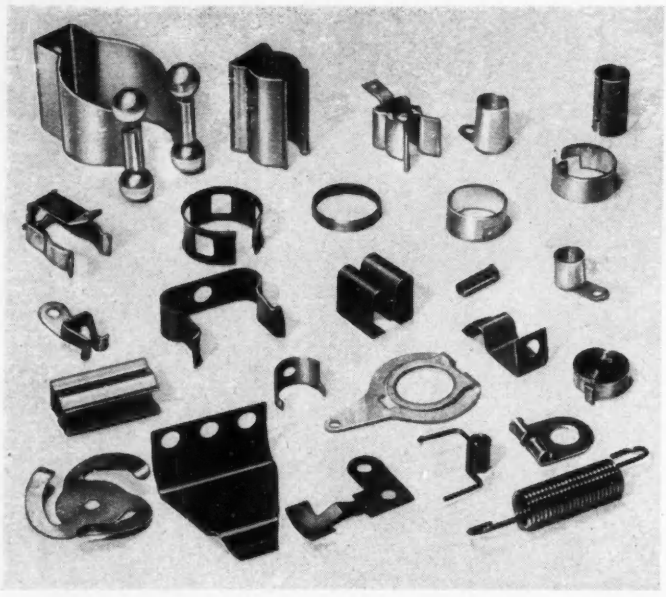
MIP

The illustration is of the Model '55' in the "Priory" range

GD11
MEASURING INSTRUMENTS (PULLIN) LTD. Electrin Works, Winchester St., Acton, London, W.3 Tel: ACOrn 4651, 4995 & 8801

EE 8149 *for further details*

EE 8150 *for further details*



Precision Tools and Pressings, Springs

IN ALL METALS TO THE FINEST LIMITS FOR THE ELECTRONIC, AIRCRAFT AND OTHER PRODUCTIVE INDUSTRIES.

Electro Erosion for General Tool Making for the Trade.

Springs and wire shapes in all metals. Helical tension compression and torsion springs from 40 S.W.G. to 3/16 dia. wire. Fuse Clips. Transistor Holders. Contact Springs and cable sleeves from transfer presses and progressive press tools.

FULLY A.I.D. AND A.R.B. APPROVED

SPRING STEEL PRODUCTIONS LTD

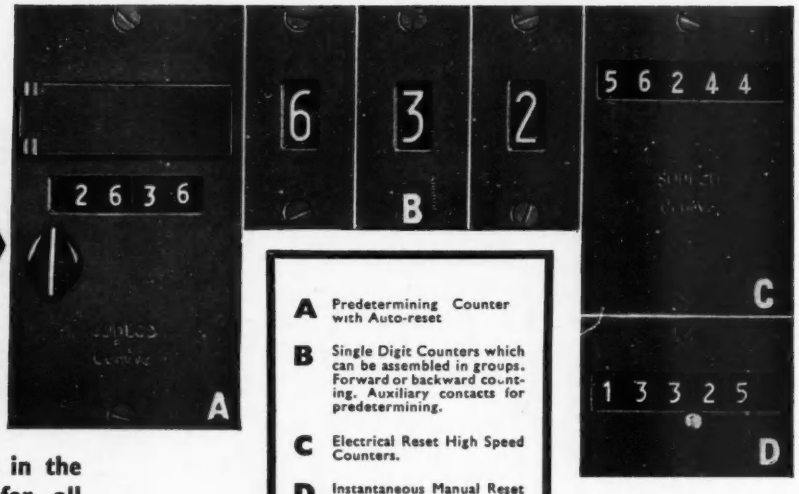
784-788 HIGH ROAD, TOTTENHAM, LONDON, N.17. *Tel: TOTTENHAM 0732/0940*

---

small

impulse

counters



A Predetermining Counter with Auto-reset

B Single Digit Counters which can be assembled in groups. Forward or backward counting. Auxiliary contacts for predetermining.

C Electrical Reset High Speed Counters.

D Instantaneous Manual Reset High Speed Counters. 10 or 25 impulses per (second).

Our range of counters offers in the most compact form types for all requirements. The total full size width of the group above is only 6 inches.

Send for full details of the above and other counters in our range to

STONEBRIDGE CONTROLS & INSTRUMENTS

THE STONEBRIDGE ELECTRICAL CO. LTD.
6 Queen Anne's Gate · London · S.W.1
Telephone: TRAfalgar 1444

Agents and Licensees in U.K. for "SODECO", GENEVA.

EE 8151 *for further details*

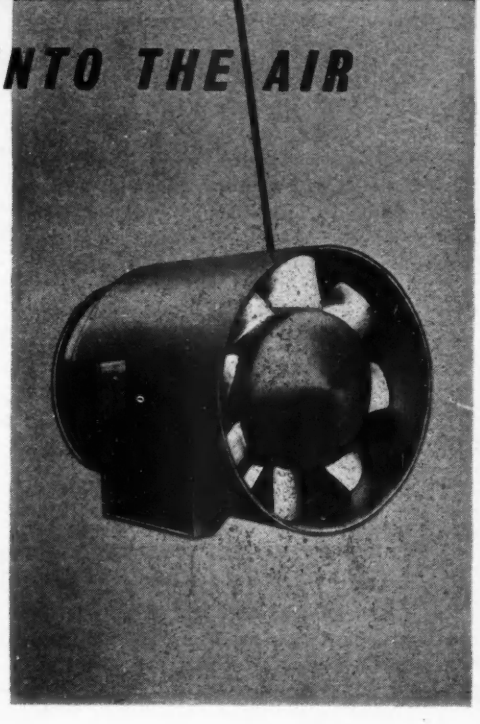
Crown Copyright reserved, reproduced by permission of the Controller, H.M. Stationery Office.

GETTING BLOODHOUND INTO THE AIR

For the launching gear of the Bristol/Ferranti Bloodhound a 15" diameter high pressure axial cooling fan was developed specially by Air Control Installations Ltd.

Once again Air Control products have proved that they measure up to the most stringent specifications. And it is reassuring to know that a firm like Air Control make cooling fans for *every* electronic's application.

May we send you full details of the complete range (from which many models are available from stock)?



AIR CONTROL
INSTALLATIONS LIMITED

RUISLIP · MIDDLESEX · RUISLIP 4066
LONDON · BIRMINGHAM · MANCHESTER NEWCASTLE · GLASGOW

FILTERS DUST COLLECTORS AIR CONDITIONERS FANS FILTERS DUST COLLECTORS AIR CONDITIONERS FANS FILTERS DUST

ELECTRONIC | COMPONENT
C.C.L. LTD.
MANUFACTURERS

R.E.C.M.F. Exhibition STAND 137

SPECIALISTS IN ELECTROLYTIC CAPACITORS

Mr. O. G. Cox and Mr. F. O. Booth will be in attendance and cordially invite you to meet them.

Hanworth Lane,
Chertsey, Surrey England.

Telephone :
CHERTSEY 3438/9
PBX.

SPECIALIST HAND TOOLS
FOR THE ELECTRONIC AND TELEPHONE INDUSTRIES

These pocket sets of special small hand tools provide a basic kit of instruments, suitably protected and easily carried. A necessity for all those engaged in the adjustment and maintenance of telephone and electronic apparatus, these specialist packs can be supplied containing any selection of tools required, with strap loops to fit each individual tool. We shall be glad to offer our advice and submit quotations for these kits in small or large quantities.

We make a wide range of specialist hand tools, adjusters and plier-type tools to specifications of the G.P.O., and to your own requirements. Our catalogue is available on request.

LIGHTWOOD

LIGHTWOOD & SON LTD. PRICE STREET, BIRMINGHAM 4

Telephone and Telegrams: ASTon Cross 2622

EE 8154 *for further details*

RESISTANCE WIRES AND TAPES
of highest grade

Fully complying with relevant British Standards

in

Nickel Chromium
Nickel Chromium Iron
Copper Nickel
Pure Nickel

also

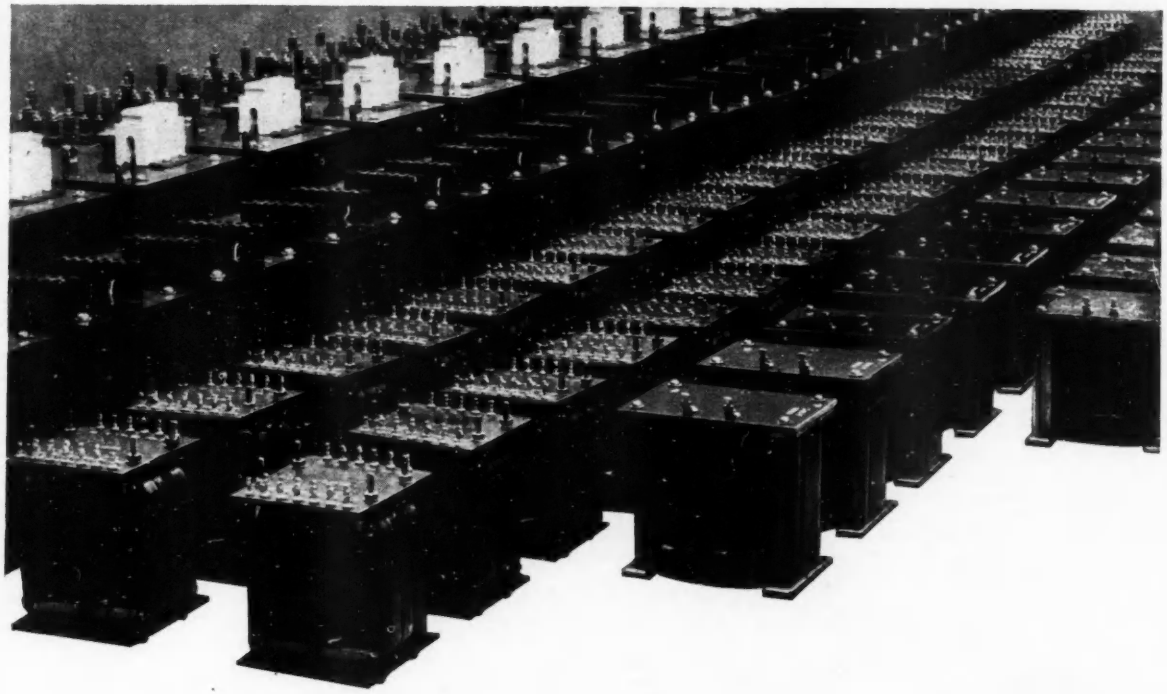
Stainless Steel
and
Fine Titanium

Resistance wires supplied down to 0.0006"
and with characteristics
suitable for vitreous enamelling

ALLOY WIRE CO. LTD.
Lawrence Lane, Old Hill, Staffs.

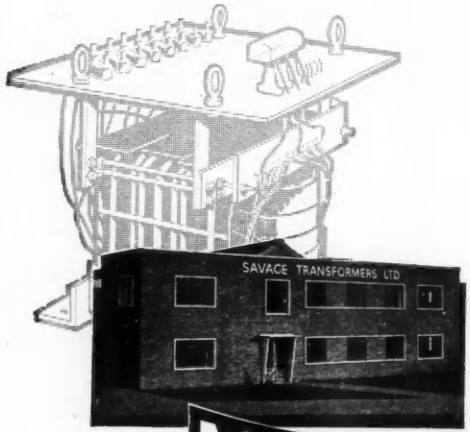
Telephone: Cradley Heath 667/5. Telegrams: Wireloy, Cradley Heath

EE 8155 *for further details*



special repeat performances

We specialise in designing transformers for special requirements in industry. There is no mass production at Savage Transformers Ltd., but there is quantity production—the difference is important for it means that several hundred Massicore transformers are made with the same care and individual attention as the original prototype.
We are delighted to do 'one off', particularly if it is a new or tricky one . . . it keeps our boffins on their toes and enables us to learn and develop new techniques. We are even more delighted to copy it several hundred times, for that keeps our works staff busy and happy. **If you have a transformer problem send it to—**



THE LITTLE FACTORY
WITH THE BIG REPUTATION

SAVAGE TRANSFORMERS LIMITED
NURSTEED ROAD, DEVIZES, WILTS
Tel: Devizes 932

MASSICORE SAVAGE

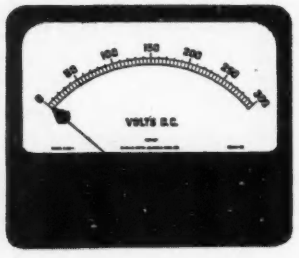
EE 8157 *for further details*

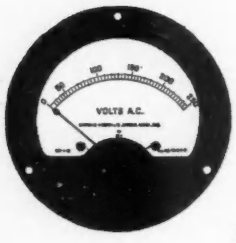
WESTON PANEL INSTRUMENTS

Complete flexibility in panel design is made possible by the Weston range of "miniatures" which includes round, rectangular and edgewise models. Round models are housed in cases of 2", 2¼" and 3½" diameter . . . or, to harmonise with rectangular panels, the rectangular type is available, giving an increase in scale length of approximately 50% over the equivalent round models. Horizontal edgewise instruments are available with scale lengths of 2¼" and 3¼".

Moving iron, moving coil, a.c. rectifier and h.f. thermocouple models are offered—all with the accepted Weston qualities of accuracy and reliability.

Full particulars are to be found in leaflets—Lists Nos. W1, W2, W3 and W4, copies of which are available on request.





SANGAMO WESTON

SANGAMO WESTON LTD · ENFIELD · MIDDLESEX

Tel: ENField 3434 (6 lines) & 1242 (6 lines). Grams: Sanwest, Enfield.

Scottish Factory : Port Glasgow, Renfrewshire, Port Glasgow 41151 · Branches : London, CHAncery 4971 · Glasgow, Central 6208 Manchester, Central 7904 · Newcastle-upon-Tyne, Newcastle 26867 · Leeds, Leeds 30867 · Liverpool, Central 0230 · Wolverhampton, Wolverhampton 21912 · Nottingham, Nottingham 42403 · Bristol, Bristol 21781 · Southampton, So'ton 23328

SW/68

NOISE MEASURING EQUIPMENT TYPE 123

Essentially a narrow-band R.F. Spectrum Analyser, Noise Measuring Equipment Type 123 may be used for determining the spectra of spurious a.m. and f.m. modulations at frequencies close to carrier. The instrument is particularly suitable for analytical work on the performance of oscillators and systems developed for c.w. doppler radar applications.

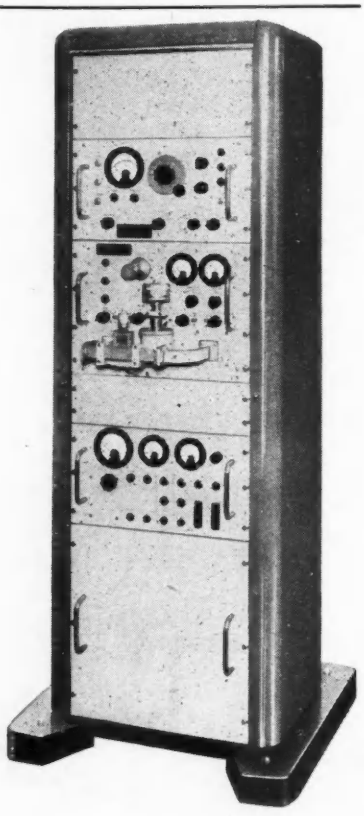
Operating Frequency: Full sensitivity may be achieved over a bandwidth ±5% relative to carrier. The equipment illustrated is fitted with an X-band R.F. head.

Spectrum Analyser range: From 1-90 Kc/s with respect to carrier.

Resolution: 70 c/s or 1 Kc/s bandwidth.

Sensitivity: The r.m.s. a.m. sideband power in a 70 c/s bandwidth can be measured down to −135 db with respect to the total signal power level, with an accuracy of ±2 db and an equivalent accuracy is obtainable in f.m. sideband power measurements down to 0.01 c/s deviation.

Display: Panoramic display, with frequency marker, or alternatively, a hot-wire instrument provides accurate power measurements when used with a manually controlled sweep oscillator.



Write for information, quoting frequency bands of interest, to:

JAMES SCOTT & CO. (Electrical Engineers) LTD.

Manufacturing and Electronics Division
68 BROCKVILLE STREET,
CARNTYNE INDUSTRIAL ESTATE,
GLASGOW, E.2.

Telephone : SHEttleston 4206/9

EE 8158 *for further details*

EE 8159 *for further details*

Precision Servo Components

Now—time is on your side when miniature servo components are involved.

Vactric (Control Equipment) offer a complete series of the highest quality for extreme operating conditions.

DC MOTORS
Permanent magnet type in International Frame Sizes from 08 to 18.

AC MOTORS
Servo and Synchronous 2 phase motors in Frame Sizes 07 to 18.

GEARHEADS
Precision type Sizes 10, 11, 15 and 18; standard ratios up to 600:1

MOTOR GENERATOR
Size 11 comprising 2 phase servo motor and linear speed torque generator.

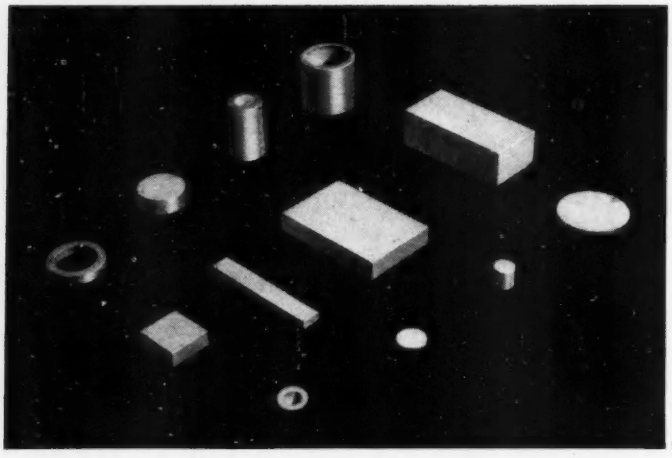
ROTARY SWITCHES
High speed, low noise level, samples up to 4800/sec. on one wafer.

BREADBOARD
Range of standard components for prototype servo systems.

. . . Keep you ahead of schedule!

Vactric (Control Equipment) Limited
Vactric House, Sloane Street, London, S.W.1. Telephone SLOane 9656

EE 8160 *for further details*



Piezoelectric Ceramics

Improved polycrystalline ceramic materials for all piezoelectric applications including gramophone pickup elements, accelerometers and pressure cartridges, flaw detection probes and high power ultrasonic transducers.

	TYPE LZ-4A	TYPE LZ-5A
k_p	0.600	0.540
k_{31}	0.355	0.318
d_{31}	-107×10^{-12}	-140×10^{-12} coul/Newton
K_3	1350	1500
Density	7.6	7.5 grams/cc
Resistivity	$> 10^{13}$	$>10^{13}$ ohm. cm
Mechanical Q	500	75
tan δ	0.004	0.02

Brush Crystal Co. Ltd.

SHORE ROAD · HYTHE · SOUTHAMPTON

TELEPHONE: HYTHE (Southampton) 3031-2 CABLES: BRUDEV. HYTHE SOUTHAMPTON

Jason **STABILISED POWER PACK**

IN KIT FORM OR READY BUILT

Available in kit form complete with case and valves or ready built and tested.

Details of this and other Jason Test Equipment in Kit Form or ready built on request

MAINS INPUT
110, 205, 225, 245 volts A.C., 50/60 cycles.

OUTPUT VOLTAGE AND CURRENT
300/350 volts at 175mA.
Unit must be derated for lower output voltages as follows:—275V, 160mA; 250V, 150mA.

POLARITY
Chassis may be connected to either positive or negative, or may be left floating by means of a 4-way switch ganged with Mains On-Off position.

RIPPLE—Less than 1mV

STABILITY WITH MAINS VARIATIONS
±10% mains fluctuation produces less than 0.15% variation in output voltage.

IMPEDANCE MEASUREMENTS
D.C. Output, less than 1Ω.
A.C. measured with 10mA, A.C. at 100~ frequency, D.C. current between 40-175mA—*less than* 1Ω).
A.C. output impedance measured with 10mA. A.C. at 100~, D.C. current less than 40mA—*approx.* 1Ω).

METER FACILITIES
0-200mA, F.S.D.; 0-500V, F.S.D.
Meter switch ganged with H.T. OFF switch.

MODEL PP20
Complete Kit, **£16.5.0.**
Ready Built, **£20.6.0.**

MODEL PPM20
With Metering
Complete Kit, **£22.10.0.**
Ready Built, **£27.15.0.**
In course of preparation 240V 80mA type with similar performance.

PP10 Kit, **£12.15.0**; Built, **£16. 0.0.**
PP10M Kit, **£19. 0.0.**; Built, **£23.15.0.**

PROFESSIONAL DISCOUNTS

THE JASON MOTOR & ELECTRONIC CO., 3-4 (C) GT. CHAPEL ST., OXFORD ST., LONDON, W.1 *GER 0273/4*

BRITISH DESIGNED TO HIGH TECHNICAL STANDARDS

EE 8161 *for further details*

EE 8162 *for further details*

accurate . . . . uniform . . . . precision made

For every type of resistor 'Vacrom' can be supplied fully annealed in either bright or oxydised finish. 'Eureka' is supplied in accordance with BSS 115/1954 or to customers own specification.
'Vacrom' and 'Eureka' resistance wires can be supplied BARE or with STANDARD COVERINGS of cotton, silk, rayon, enamel and glass.

RESISTANCE WIRES

Vacrom & Eureka
Regd. Regd.
NICKEL-CHROME CUPRO-NICKEL

STAND No. 89 — STAND No. 68
R.E.C.M.F. EXHIBITION

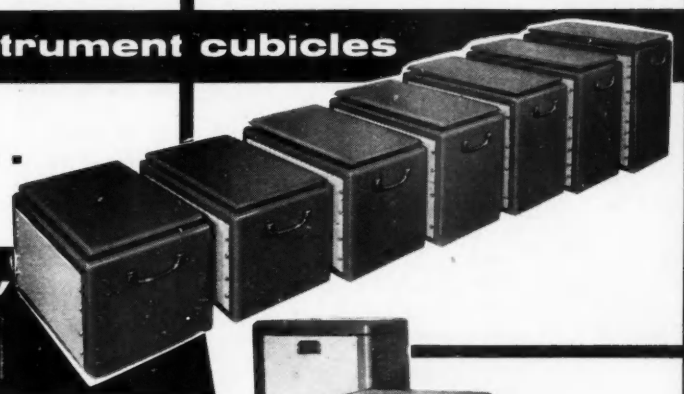
Insulated Wires L·E·W THE LONDON ELECTRIC WIRE COMPANY AND SMITHS LTD · LEYTON · LONDON · E.10

Bare Wires VACTITE VACTITE WIRE COMPANY LIMITED · 75 ST. SIMON STREET · SALFORD 3 · LANCS

electronic instrument cubicles

range from..

7"–72"



★ This range of Cabinets meets the general requirements of the Electronics Industry and are of high quality, precision built to close limits.
★ Drilled and tapped 1 B.A. for 19" Panels. Standard finish is stove enamel to B.S.C. 381C. Colour: dark grey 632.
★ Tropical finishes, or other colours, at extra cost.
★ Delivery Ex-Stock.
★ Fully illustrated leaflet sent on request.

THE P&H ENGINEERING COMPANY LTD.
Huntingdon. Tel: 28

EE 8163 *for further details*

Miniature Transformer Techniques

FOR THE G.W.- ELECTRONICS AND AIRCRAFT INDUSTRIES

Full production backed up by a comprehensive Design and rapid Prototype Service, from the smallest possible Transformers and Windings to normal sizes, using up to 52 s.w.g. wire.

- **OPEN TYPES**
- **CANNED TYPES**
- **RESIN ENCAPSULATED**
- **VACUUM IMPREGNATED**
- **SUB-MINIATURE (or smaller)**

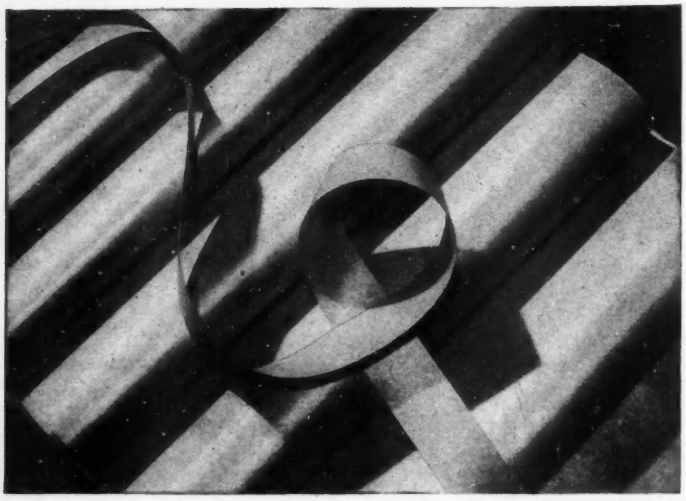
Belclere REGD. TRADE MARK

AID APPROVED

THE BELCLERE CO.

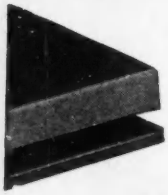
171 COWLEY ROAD OXFORD

Phone Oxford 3430 & 3432 Cables Belclere Oxford



DIELECTRIC PLUS

Insulating cloths and tapes manufactured by IOCO LIMITED provide the necessary dielectric strengths appropriate to various classifications. In addition they possess properties of thermal stability, mechanical strength, moisture resistance, flexibility, toughness and minimum bulk which fit them for service under almost any conditions in any part of the world. Full technical literature will be sent on request.



FORMAPEX

Laminated plastic boards and sheets, paper or fabric based, are used widely for terminal boards, switchgear, rigid insulation, etc.

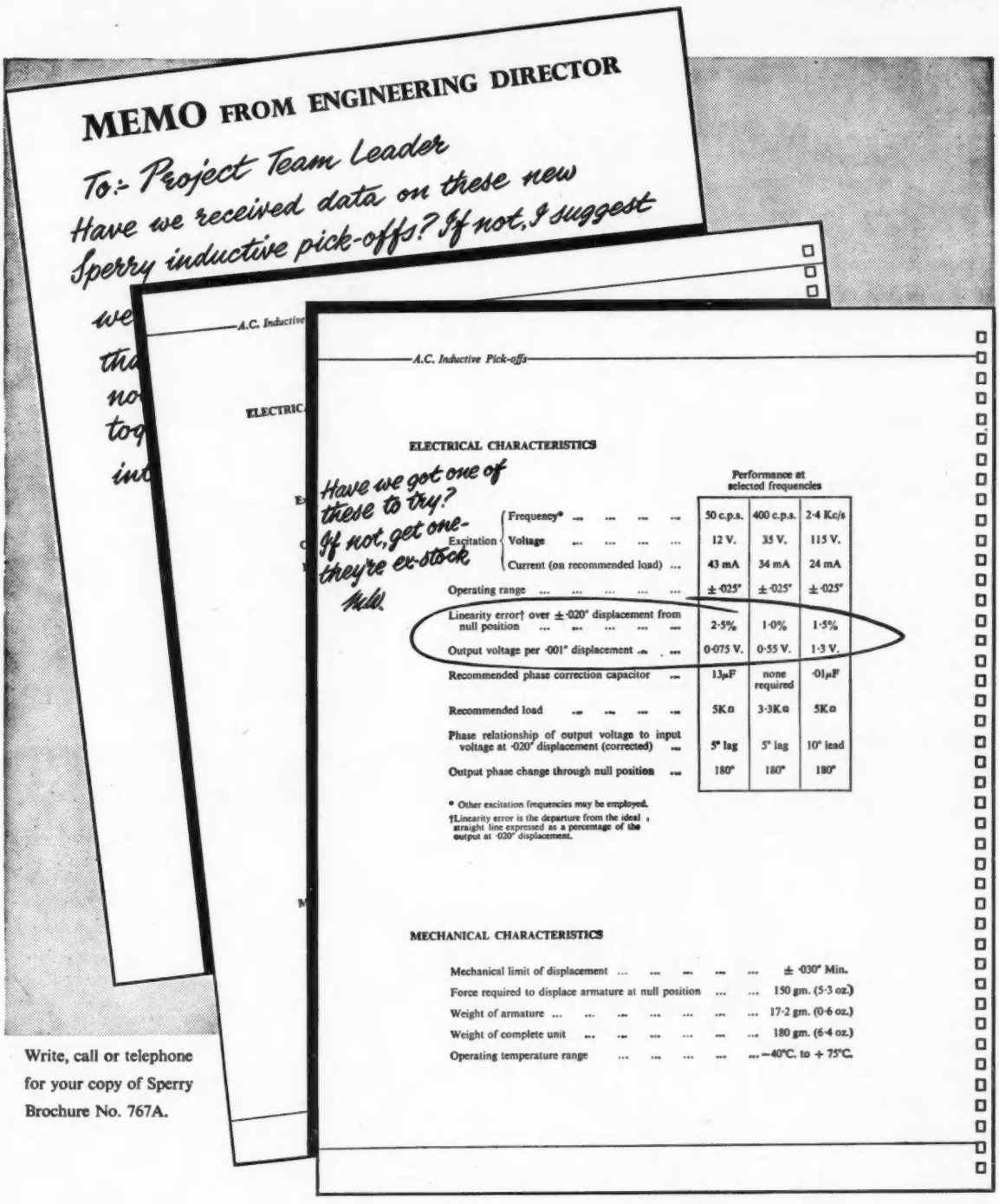
***For cable and general service* LINAPEX**

—cotton, silk, nylon, or glass fabric base coated with specially developed varnishes. Available in various thicknesses, straight or bias cut.

IOCO

IOCO LIMITED

ANNIESLAND · GLASGOW, W.3 · Telephone: Scotstoun 5501-6


MEMO FROM ENGINEERING DIRECTOR
To:- Project Team Leader
Have we received data on these new
Sperry inductive pick-offs? If not, I suggest
A.C. Inductive Pick-offs
ELECTRICAL CHARACTERISTICS
Have we got one of these to try? If not, get one- they're ex-stock
Performance at selected frequencies
Frequency* ... ... 50 c.p.s. 400 c.p.s. 2·4 Kc/s
Excitation Voltage ... ... 12 V. 35 V. 115 V.
Current (on recommended load) ... 43 mA 34 mA 24 mA
Operating range ... ... ±·025" ±·025" ±·025"
Linearity error† over ±·020" displacement from null position ... ... 2·5% 1·0% 1·5%
Output voltage per ·001" displacement ... ... 0·075 V. 0·55 V. 1·3 V.
Recommended phase correction capacitor ... 13μF none required ·01μF
Recommended load ... ... 5KΩ 3·3KΩ 5KΩ
Phase relationship of output voltage to input voltage at ·020" displacement (corrected) ... 5° lag 5° lag 10° lead
Output phase change through null position ... 180° 180° 180°
* Other excitation frequencies may be employed.
†Linearity error is the departure from the ideal straight line expressed as a percentage of the output at ·020" displacement.
MECHANICAL CHARACTERISTICS
Mechanical limit of displacement ... ... ± ·030" Min.
Force required to displace armature at null position ... ... 150 gm. (5·3 oz.)
Weight of armature ... ... 17·2 gm. (0·6 oz.)
Weight of complete unit ... ... 180 gm. (6·4 oz.)
Operating temperature range ... ... −40°C. to + 75°C.
Write, call or telephone for your copy of Sperry Brochure No. 767A.

SPERRY A.C. INDUCTIVE PICK-OFFS

to signal linear or rotary displacements

ENGINEERING, MARINE, WELDING & NUCLEAR ENERGY EXHIBITION, **APRIL 16th to 30th, STAND No. 9 ROW F GRAND HALL**

SPERRY GYROSCOPE COMPANY LIMITED, GREAT WEST RD., BRENTFORD, MIDDLESEX

ISLeworth 1241 Telex 23800

EE 8167 *for further details*

ELCOM

THE 'ELCOM' 10F POTENTIOMETER

is an item from the proven range of Electronic Components

Elcom offers components of an established quality, at an economic price level and with the kind of delivery that you are seeking.

Did you know for instance that Elcom Plugs and Sockets, 2 to 33-way, are available Ex-Stock?

For details of PLUGS AND SOCKETS

FADERS AND ATTENUATORS . ROTARY STUD SWITCHES . PRECISION WIRE-WOUND RESISTORS

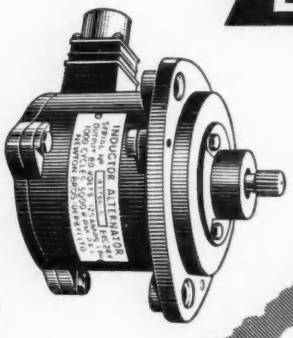
WRITE OR TELEPHONE

ELECTRONIC COMPONENTS

WEEDON ROAD INDUSTRIAL ESTATE · NORTHAMPTON

NORTHAMPTON 2467 AND 1873 **GRAMS: 'ELCOM' NORTHAMPTON**

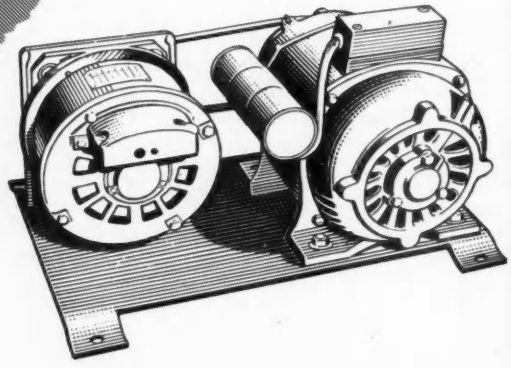
ELECTRICAL EQUIPMENT



10/20 VA 1000 c.p.s., 1 phase, 3000 r.p.m. wound field or permanent magnet excitation

Write for Illustrated Brochure.

High Frequency Motor Alternator Set. 1kVA, 115 volts, 1600 c.p.s., single phase



NEWTON DERBY

NEWTON BROTHERS (DERBY) LIMITED

ALFRETON ROAD · DERBY

PHONE: DERBY 47676 (4 LINES) GRAMS: DYNAMO, DERBY

London Office: IMPERIAL BUILDINGS, 56 KINGSWAY W.C 2

EE 8168 *for further details*

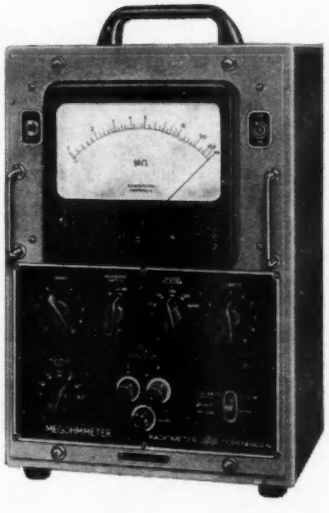
EE 8169 *for further details*

Megohmmeter

TYPE IM5

1 MEGOHM TO 100 MILLION MEGOHMS
measured at:

50, 100, 200, 500, and 1,000 VOLTS d.c.



- This new Hundred Million Megohmmeter offers high stability, large easy-to-read scale, and simple operation.
- Fast charge and automatic discharge networks permit fast and safe measurements on capacitors.
- Built-in leakage current guard.

Meter scale calibrated from 1 to 100 Megohms with 7 range multipliers: x1, x10, . . . , $x10^6$.

Accuracy from 2% to 5% depending on range.

Write for complete information

Radiometer offers a line of 50 different instruments such as

AF-OSCILLATORS
R-L-C BRIDGES
SIGNAL GENERATORS
VACUUM-TUBE VOLTMETERS
WAVE ANALYZERS
ELECTROCHEMICAL INSTRUMENTS

RADIOMETER

72 Emdrupvej, Copenhagen NV-3, Denmark

Represented in Great Britain by
Livingston Laboratories Ltd.
Retcar Street, London, N.19

EE 8170 *for further details*

your equipment needs

Insuloid

CABLE CLIPS

Every year more and more millions of Insuloid Cable Clips are supplied to the Radio, Electronic, Switchgear, Domestic Appliances, Aircraft, Marine Engineering, Atomic Energy, Electrical Contracting and Laboratory Equipment manufacturing industries . . . that's real proof of satisfaction and service by Insuloid NX, CY and X type Cable Clips. Insuloid Cable Clips secure cables, tubes and components wherever a high grade and secure fixing is required. For guaranteed reliable service in all climatic conditions.

NX CLIP

Made from highest grade nylon, stronger than metal and twice as light, in sizes from $\frac{1}{4}$ in. to 1 in. inside diameters.

CY CLIP

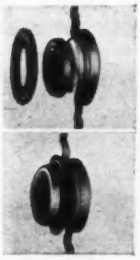
For dual cable runs in seventeen sizes, covering cable diameters $^{5}/_{32}$ in. up to $^{21}/_{32}$ in. In highest grade hard P.V.C.

X CLIP

Manufactured in highest grade hard P.V.C. in twenty-five different sizes from $\frac{1}{4}$ in. inside diameter to 2 in. inside diameter to cover the smallest and largest wiring runs.

. . and the bush which simply won't come out!

Insuloid 'RING LOCK' BUSH



Here's a bush specially designed for instant assembly. The Insuloid simple snap-on finger action is as quick as a thought and once it's fixed it stays fixed, guaranteeing no chafing, and no tools are required whatsoever.

Insuloid Ring Lock Bush is non-metallic, fully tropical, high dielectric, is approved by all services and is completely secure under all working conditions. Another Insuloid time-and-money-saving component.

Send for fully descriptive literature covering the full range of Insuloid Cable Clips and Ring Lock Bushes today.

INSULOID MANUFACTURING CO., LTD
Sharston Works, Leestone Road, Wythenshawe, M/C
Tel: WYT 2842 & 3163 Grams: Insuloid, Manchester

COME AND SEE US ON STAND Q4 AT THE A.S.E.E. EXHIBITION, EARLS COURT

EE 8171 *for further details*

Visit the . . .

INTERNATIONAL CONGRESSES AND EXHIBITION

June 15th *ROME* July 5th 1959

ATOMIC ENERGY · ELECTRONICS
AUTOMATION · TELEVISION FILMS

Full details obtainable from:

Rassegna Internazionale Elettronica,
Nucleare, Teleradiocinematografica
Via della Scrofa 14, Rome, Italy

and from:

Auger & Turner Group Ltd.
40 Gerrard St., W.1.
Telephone: GERrard 4951/9

EE 8172 *for further details*

MAKING IN MILLIONS

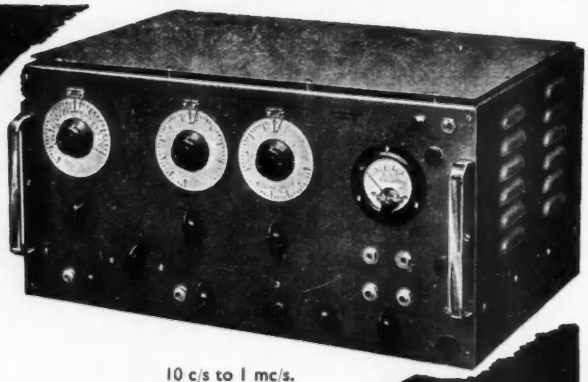
FLEXIBLE TERMINAL BLOCKS

These components provide great flexibility in two planes, and can be screwed to curved or irregular surfaces without danger of shattering. The P.V.C. moulding is easily cut with a knife. Insulates and grips terminal screws firmly even if the blocks are mounted upside down.

Regd. BL

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD ENFIELD. MIDDX. ENGLAND
Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

PULSE GENERATOR
TYPE 302A
General Purpose LABORATORY INSTRUMENT



½ amp. peak current available in output
0 to 100 volts continuously variable output
Fully Regulated Internal D.C. supplies
Rise Times of 0.015 μS
Low output impedance
Extremely small jitter

SPECIFICATION:

Oscillator frequency:	10 c/s to 1 mc/s.
Delay:	0.3 μs. to 10 ms.
Pulse width:	0.1 μs. to 10 ms.
Pulse amplitude: (positive or negative)	0 to 30 volts into 75 ohms. 0 to 100 volts into 1000 ohms.
Square waves:	10 c/s to 1 mc/s.

The instrument can be synchronised or triggered from an external source.

Send for details

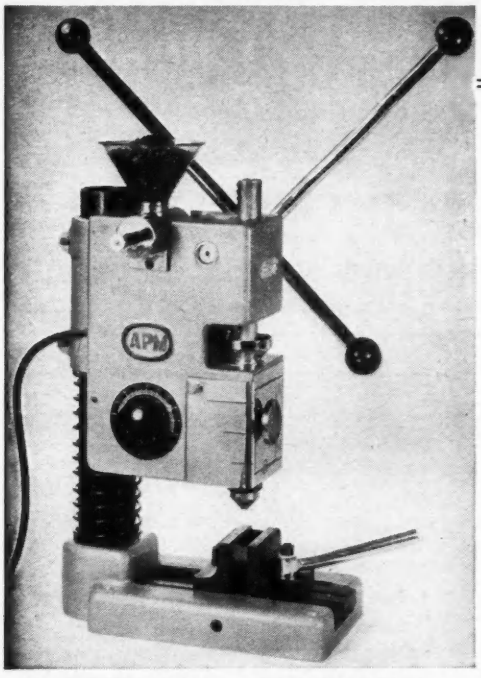
ALSO AVAILABLE
DOUBLE PULSE GENERATOR
TRANSISTOR ANALYSER
STABILISED POWER SUPPLIES
both high voltage and low voltage giving cutput currents of 50 mA. to 10 amps.

SM

KASAMA ELECTRONICS LTD.
ILEX WORKS, 10, NORTHWOLD ROAD, LONDON, N16
Telephone: STAmford Hill 3513

EE 8173 *for further details*

SMALL COMPONENTS FOR THE ELECTRONIC INDUSTRY ARE MADE ON THE



APM 21

HAND OPERATED BENCH INJECTION MOULDING MACHINE

Suitable for working POLYSTYRENE & POLYTHENE with normal cylinder—NYLON and DIAKON with special cylinders.

Capable of Production Rates depending upon mould design up to *300 injections per hour* without special skill.

ALTERNATIVE TYPES OF VICE NOW AVAILABLE

- Improved Cam-Lock with milled knob adjustment of jaws
- Special vice for horizontally split dies
- Ejector type vice for fast cycling.

Particulars from

ASMIDAR PLASTIC MOULDING MACHINES LTD.

116 VICTORIA STREET, LONDON, S.W.I. Telephone: VICtoria 5554

Up-to-date manufacturing methods make . .

Eclipse LOUD SPEAKER MAGNETS

SUPREME FOR

PERFORMANCE AND VALUE *

Investigate the technical and economic advantages of Semi-Columnar Alcomax.

FINISH * * * *

Manufacture by Shell-Moulding.

*Write for literature

PM 108/56—Loud Speaker Magnets.

PM 169/57—Semi-Columnar Alcomax Magnets.

Bulletin M 10/57—Eclipse Shell-Moulded Permanent Magnets.

Made by the designers and manufacturers of Eclipse Permanent Magnet Chucks

JAMES NEILL & CO. (SHEFFIELD) LTD · SHEFFIELD · ENGLAND

EE 8175 for further details

EE 8176 *for further details*

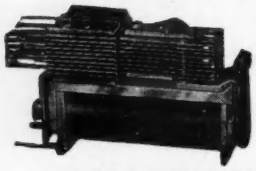
Wilkinsons for RELAYS

EST. 1921

P.O. TYPE 3000

BUILT TO YOUR SPECIFICATION

Contacts up to 8 changeover

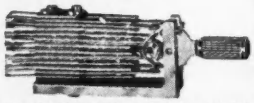


QUICK DELIVERY

KEEN PRICES

KEY SWITCHES

ALL TYPES UP TO 4CO/6CO



RACKS—POST OFFICE STANDARD. 6 ft. high with U-channel sides drilled for 19 in. panels, heavy angle base, 4 ft. 10 in. also in stock.

VARIABLE TRANSFORMER 230 volts A.C. 50/60 cycles. Output infinitely variable from 0-270 volts 9 amps. Brand new £15 cge. 12/6.

QUANTITIES AVAILABLE • CALLERS WELCOME • WRITE FOR LISTS

P.O. Racks
Micro-ammeters
Milliameters
Ammeters
Voltmeters
Meggers
Magnetic Counters
Loudspeakers
Rectifiers
Chargers
Telephones
Condensers
Potentiometer
Resistors
F.H.P. Motors
Switches
Fans
Blowers
Regulators
Contactors
Plugs
Sockets
Terminals
Thermostats
Elements
Oscilloscopes
Jacks
Fuses
Lamps
Cable
Receivers
Transformers
Chokes
Insulators
Valves
Pumps
Converters
Headphones
Microphones

L. WILKINSON (CROYDON) LTD.

19 LANSDOWNE RD. CROYDON SURREY

Phone: CRO 0839 Grams: WILCO CROYDON

EE 8178 *for further details*

PRESSINGS AND WIRE SHAPES

In all metals to the finest limits for the Electronics and other Industries.

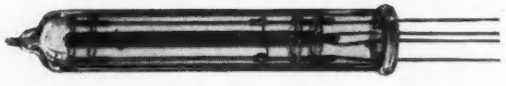
Large or small quantities.

K. C. CLIPS LTD.

Moat Farm Works,
King's Coughton, Alcester, Warwickshire

Telephone: Alcester 119.

EE 8179 *for further details*



For use in miniaturised equipment, Q.C.C. Type MG. Quartz Crystal Units are available for the frequency ranges of 9 to 20 kc/s, and 65 to 130kc/s.

The illustration above is full size. For full particulars, please ask for leaflet MG.

When it's crystals, think of Q.C.C. first!

THE QUARTZ CRYSTAL Company Ltd.

Q.C.C. Works, Wellington Crescent, New Malden, Surrey

Telephone: MALden 0334 & 2988 Grams & Cables: Quartzco, New Malden

STAINLESS STEEL

. . . just one of the metals in which we produce small pressings to any accuracy and in any quantity. The grille shown is produced continuously from stainless steel strip on an automatic transfer machine. Write to us today, your enquiry will receive our immediate attention.

H. A. LIGHT

(Productions) LTD.

Winster Grove, Shady Lane, Kingstanding, Birmingham 22a.

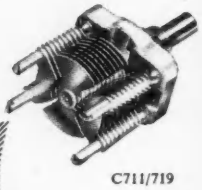
Telephone: GREat Barr 4211/2

London Office: **St. George's House, 44 Hatton Garden, London E.C.1**

Telephone: CHAncery 5776

EE 8177 *for further details*

Jackson Brothers Butterfly Vane Trimmer, type C711/719, with capacity of up to 65 P.F. with 0.015 in. air gap (each half) and up to 15 P.F. with 0.045 in. air gap (each half).

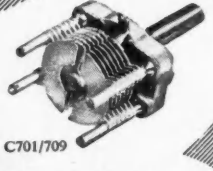


C711/719

NEW RANGE OF TRIMMERS

It's reliable . . . if it is made by

JACKSON BROS. (LONDON) LTD



C701/709

Jackson Brothers Trimmer, type C701/709. Differential Condensers with capacities of up to 150 P.F. with 0.015 in. air gap (each half) and up to 30 P.F. with 0.045 in. air gap (each half).

KINGSWAY · WADDON · SURREY Telephone Croydon 2754/5

EE 8180 *for further details*

WODEN TRANSFORMER CO. LTD

TORQUE MOTORS

for application

TYPICAL FEATURES AND PERFORMANCE DETAILS OF WODEN RANGE OF TORQUE MOTORS

TYPE MARK E.12

Moment of inertia of relay armature	3.8 × 10.7 slug ft 2
Stiffness factor of relay armature	0.196 lb.ft/radian
Damping factor of the relay armature	1 × 10-4lb.ft/ rad/sec
Torque constant of the relay	10.2 lb./ft/amp.
Back E.M.F. constant of the relay	14.3 volts/rad/sec
Coil impregnation	Solventless varnish

TYPE MARK E.13

A new development which has an almost identical performance to the Mark E.12, but is designed as a split pole piece assembly and a bobbin type coil which is a separately encapsulated assembly. This unit is offered as being, climatically superior.

TYPE MARK E.14

Constructionally as Mark E.12 but windings are on a special type core and this unit has a torque of 27 inch/amps at 10 mA.

TYPE MARK E.16 This is a solventless varnish impregnated design giving the following performance:

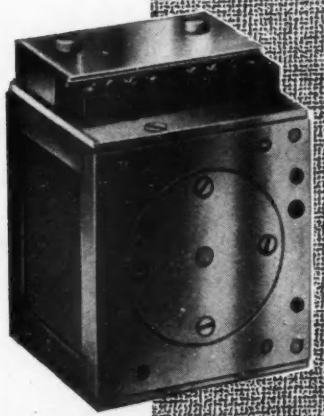
Standard coil resistance	10,000 ohms
Inductance of windings	Not less than 10H at 750~
Insulation	Not less than 20 megohms at 500 volts
Flash Test	1,000 volts 50 cycles between windings and poles
Angular Movement	Not less than 4° either side of natural centre
Deflexion Current, Full Torque Output	Not more than 7 mA for 850 gm/cms
Deflexion Current, Zero Torque Output	Not more than 1 mA for 4° movement
Dead Sector	Not more than 10% of Angular Movement
Resonant Frequency	Approximately 400 cycles

TYPE MARK E.20

This is a larger unit weighing 4 lb. 3 oz. Size 4¾" × 4" × 4" and giving the following figures:—

Linear torque output	120mA max. for 96 oz/inch
Angular Movement	±7° Natural centre
Resistance	630 ohms per side
Inductance	700 MH (unmagnetized)
Coil impregnation	Solventless varnish

Illustrated is the TYPE T.M.12 which can be used as an actuator/convertor between electronic servo or magnetic amplifiers and hydraulic, pneumatic or direct mechanical linkages.



WODEN TRANSFORMER CO.LTD | MOXLEY ROAD BILSTON · STAFFS Phone: BILSTON 42681

ZENITH
(REGD. TRADE-MARK)
"CERAMITE"
CERAMIC EMBEDDED RESISTORS
in ratings from 5 to 200 watts, values 1 ohm to 100,000 ohms.
J.S. approved in Class H.1, R.C.S.111
Is our current catalogue in your Designs and Buying Departments, or may we send you a copy complete with very competitive prices?

EE 8182 *for further details*

EE 8183 *for further details*

d-mac

TRACE ANALYSIS EQUIPMENT

This equipment is designed to aid an operator in the reading of complicated analogue traces on paper or film. At the touch of a button this machine can produce replotted graphs, punched cards, punched tape, or tabulated results as well as an illuminated digital display.

DOBBIE McINNES (Electronics) LTD.
55 KELVIN AVENUE, GLASGOW, S.W.2

Telephone: HALfway 3364

EE 8184 *for further details*

HAVE YOU A COMPONENT PROBLEM?

Pressed, Fabricated and Deep Drawn Components for the Electronic and Radio Industries are our business; whatever you need, Chassis, Cases, Panels, Fixing Brackets, etc., we can make them to your specification.

MANY STANDARD TOOLS IN STOCK

We produce in:–

STEEL · ALUMINIUM
BRASS · PHOSPHOR BRONZE
NICKEL SILVER

Self colour, plated, and/or stove enamelled.

Please send us your enquiry.

SURREY STEEL COMPONENTS LTD
74-76 Church Street, Barnes London SW13 Phone RIV 6673/5

Those interested in transistorised instruments for temperature and other variables, revolutionary in performance, reliability and cost, should be on our mailing list.

WRITE NOW!

Fielden

FIELDEN ELECTRONICS LIMITED · WYTHENSHAWE · MANCHESTER
Phone: Wythenshawe 3231 Grams: Humidity, Manchester
also AUSTRALIA, ITALY and CANADA
Branch Offices: LONDON, WALSALL, STOCKTON-ON-TEES and EDINBURGH

Indicating Recording Control

ML

EE 8185 *for further details*

MINIATURE STABILIZED
POWER UNIT

TECHNICAL SPECIFICATION

Mains Input	*: 200–250v AC*
Outputs	*: Two 4-pin sockets*
Output DC Current	*: 0-100 mA shared between sockets*
Output DC Voltages	*: 150v 200v 250v*
Regulation	*: 0·15% 0·025% 0·025%*
Voltage stabilization Ratio	*: 0·1/5 0·075/5 0·075/5*
Ripple	*: Less than 0·4mv RMS on full load*
AC Output	*: 6·3V, 2A at each socket*
Size	*: $5\frac{1}{4}'' \times 5\frac{1}{4}'' \times 5\frac{1}{4}''$*
Weight	*: Approximately $9\frac{1}{2}$ lbs*
Delivery	*: Early delivery can be given*

PAMPHLET No. 1241b ON REQUEST

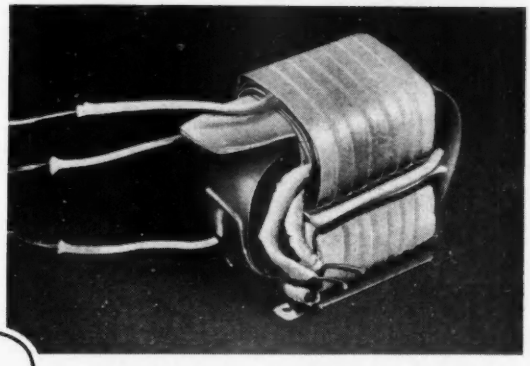
Other voltages within the range 150-250v can be supplied to order.
By means of simple links, one unit can provide any one of three output voltages.

BARR & STROUD LTD. ANNIESLAND, GLASGOW, W.3
London Office: Kinnaird House, Pall Mall East, S.W.1

FOR miniature ELECTRONIC PARTS

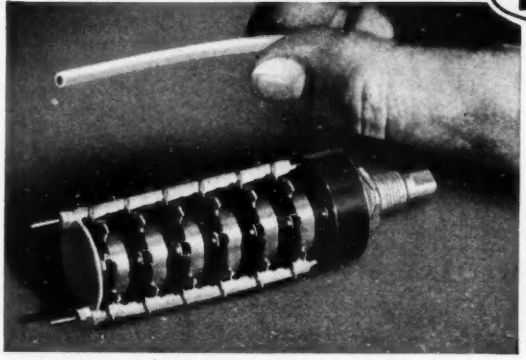
POLYPENCO FLUOROCARBON *TFE* ASSURES SUPERIOR PERFORMANCE

With increased emphasis on the miniaturization of electronic systems, Fluorocarbon *TFE* tape and thin wall sleeving are being subjected to more severe requirements than ever before. Uniform density and controlled properties in thin-walled sections are of major importance. That's why POLYPENCO/Fluorocarbon *TFE* is being used so widely in the electronics field today. Polypenco's rigid in-process testing assures you unvarying quality . . . the quality necessary to design and fabricate more minute parts and components for top performance.



Aircraft high voltage pulse transformer uses POLYPENCO Fluorocarbon *TFE* Tape insulation for interlayer case lining and terminal wrapper.

POLYPENCO Fluorocarbon *TFE* Thin Wall Sleeving used in miniature rotary tap switch combines high dielectric strength in thin sections with resistance to soldering heats.



POLYPENCO

FLUOROCARBON *TFE* Outstanding Properties

- Dielectric Constant.....2.0
- Power Factor 0.0005
- Dissipation Factor 0.0002
- Dielectric Strength, Volts/mil. 400-500
- Volume Resistivity ..10^{15} ohm-cm
- Surface Resistivity 100% R.H. 10^{13} ohm
- Water absorption .....Zero
- Fungus Resistance.....Excellent
- Services entire frequency range
- Arc Resistance—Good, leaves no carbon path regardless of time of exposure

STOCK SHAPES READILY AVAILABLE

POLYPENCO Fluorocarbon *TFE* rod, tubing and sheets are available in a wide range of sizes. POLYPENCO Fluorocarbon *TFE* Tape and Thin Wall Sleeving are made in 10 fade-proof colours for coding. Thin Wall Sleeving is available in 26 SWG sizes from No. 30 to 0. World-wide stocking and service points assure prompt delivery. The name of your nearest representative is immediately available upon request.

FABRICATING SERVICE

Custom fabricated parts are available, engineered for the best in design, quality and tolerance.

Write for latest data and bulletins.

POLYPENCO LTD.
68/70 Tewin Rd., Welwyn Garden City, Hertfordshire
Tel. Welwyn Garden 5581-2-3

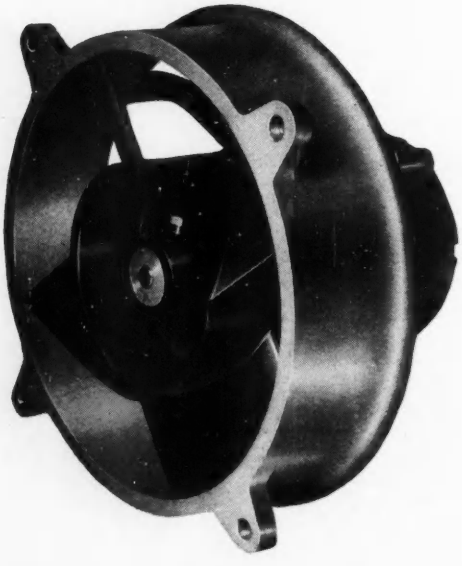
EE 8188 *for further details*

NEW

WOODS

Aerofoil fans

FOR ELECTRONIC EQUIPMENT



QUALITY AT LOW PRICE

Very keenly priced, there are three new Aerofoil short casing fans, 3.8″, 4.8″ and 6″ diam. Compact, sturdy, they offer the quality of engineering that has made the name *Aerofoil* synonymous with reliability.
Ask for Specification Sheet VW246.

WOODS OF COLCHESTER LTD.
BRAISWICK WORKS, COLCHESTER
Colchester 5111 Telex 1880
AN ASSOCIATE COMPANY OF
THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

EE 8189 *for further details*

THE A.E. RANGE OF HERMETICALLY-SEALED

1.5V STABILIZERS

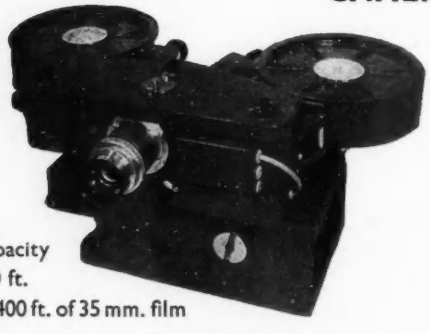
Available with and without small storage capacity in six sizes, having maximum currents between 5 mA and 1 A, and corresponding slope resistances between 12 and .06 Ω.

COVENTRY CONTROLS LIMITED
(Formerly Electronics Division Mercia Enterprises Limited)
GODIVA HOUSE . ALLESLEY OLD ROAD . COVENTRY
Telephone 72055

CINETRA

Reg'd Design No. 881830

OSCILLOGRAPH RECORDING CAMERA



Capacity
200 ft.
or 400 ft. of 35 mm. film

PROTOTYPES—EXPERIMENTAL MODELS
PRECISION GEARING AND SPROCKETS

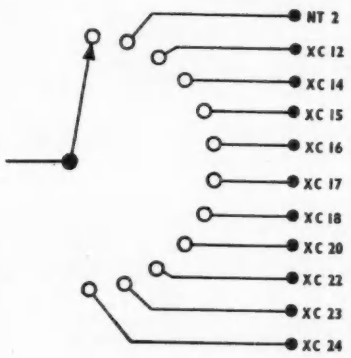
12, OVAL ROAD, LONDON, N.W.1
Telephone: GULliver 2353/4085

EE 8190 *for further details*

Switch

to Cold Cathode Tubes

for the most modern electronic switching and control systems



Hivac cold cathode tubes provide flexibility, economy, long life and reliability

the range includes

diodes
stable diodes
difference diodes
triodes and
tetrodes

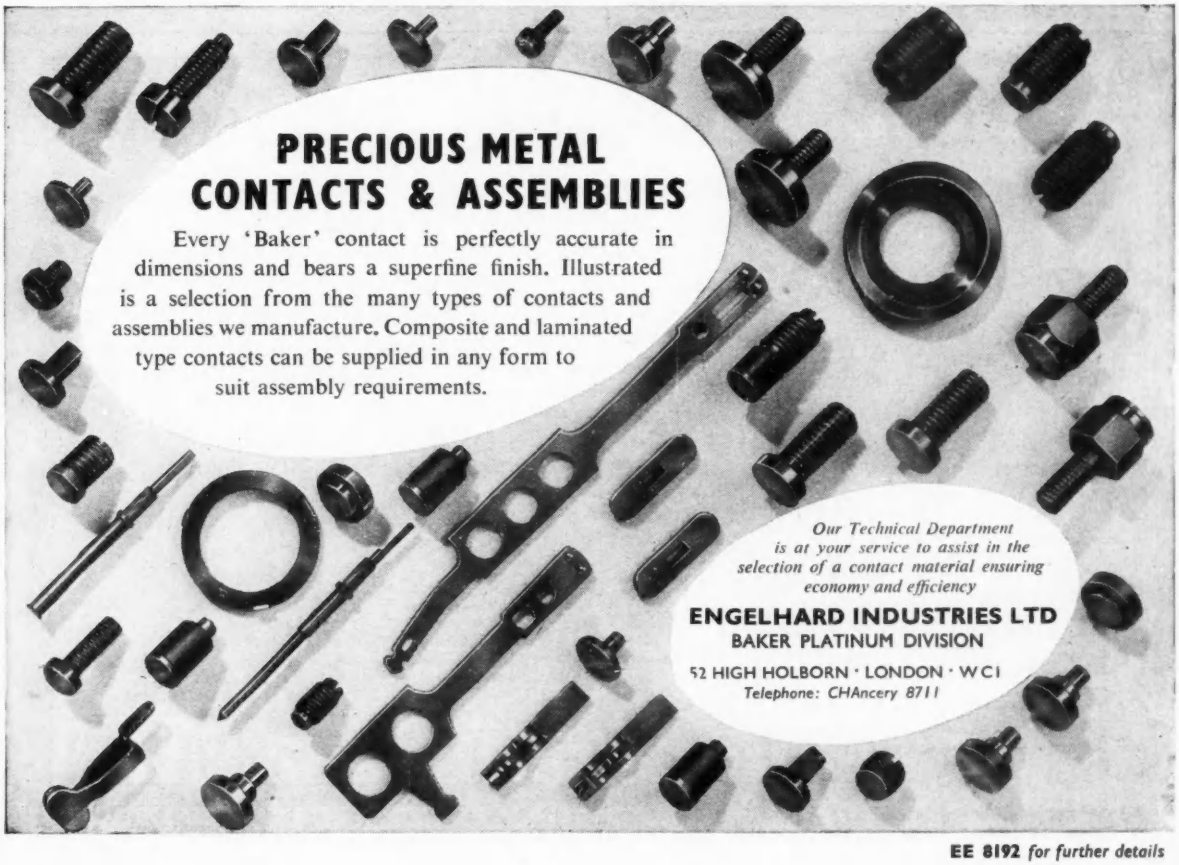
our Technical Service Department is ready to provide further details of their characteristics or application.

Hivac Limited

A member of the Automatic Telephone and Electric Group

STONEFIELD WAY · SOUTH RUISLIP · MIDDLESEX
Telephone: **Ruislip 3366**

C14b


PRECIOUS METAL
CONTACTS & ASSEMBLIES
Every 'Baker' contact is perfectly accurate in dimensions and bears a superfine finish. Illustrated is a selection from the many types of contacts and assemblies we manufacture. Composite and laminated type contacts can be supplied in any form to suit assembly requirements.
Our Technical Department is at your service to assist in the selection of a contact material ensuring economy and efficiency
ENGELHARD INDUSTRIES LTD
BAKER PLATINUM DIVISION
52 HIGH HOLBORN · LONDON · WC1
Telephone: CHAncery 8711

EE 8192 *for further details*

EE 8193 *for further details*

Important Announcement

DALE ELECTRONICS
LIMITED

IMPORTERS AND SUPPLIERS

OF ALL UNITED STATES
RADIO, ELECTRONIC AND SCIENTIFIC EQUIPMENT

→EXPRESS SERVICE←

Government and Municipal Contractors

DALE ELECTRONICS LIMITED

65 CONNAUGHT AVENUE, FRINTON-ON-SEA
ESSEX

TELEPHONE: FRINTON-ON-SEA 1276 CABLES IMPDALE, LONDON

Associates in
NEW YORK, CHICAGO AND CALIFORNIA

EE 8194 *for further details*

Precision—

SHEET METAL WORK

CABINETS · CHASSIS · CASES

P. D. OVERELL
& CO. LTD.

WINDMILL ROAD - HAMPTON HILL - MIDDLESEX.
Tel: Molesey 287

COMPLETELY INSULATED SOCKET

Aerial socket C.S.3. completely insulated with new Polythene shield; meets B/S 415 Pin Test specification. Write for details and free samples:

PANORAMA RADIO CO.
73 WADHAM ROAD, PUTNEY, LONDON, S.W.15

Also co-axial plugs CP1, & CP2
Send for details

EE 8195 *for further details*

G.E.C.

The Company will be pleased to submit quotations for the supply of vibrators of the above type to meet your specific requirements

Type VEM. 5.2 Vibrator

Ideally suitable for use in the reliability assessment of electrical and electronic components, and for fatigue testing and resonance examination, this vibrator will operate continuously at peak alternating thrusts of ± 300 lb. wt., within a frequency range extending from 10 c/s to 10 kc/s. By using a rigid moving system with no vibrating electrical connections, fatigue in the machine is eliminated, also the electrical impedance is constant over the operating frequency range.

SPECIFICATION

Thrust	± 300 lb. wt.
Force Factor	22 lb./amp.
Excursion	.25 inch (peak to peak)
Frequency Range	10 c/s — 10 kc/s
First "Table" Resonance	5 kc/s
Impedance	13 ohms at 1 kc/s
Weight of Moving System	5 lbs.
Maximum Input Power (continuous)	2 kw
Field Coil Supply	1.8 amps at 240 volts d.c.
Cooling	Forced Air (centrifugal blower)
Mounting	Vertical
Overall Height	15 inches
Diameter	17 inches

Electronics Division:
THE GENERAL ELECTRIC COMPANY LIMITED OF ENGLAND Telephone, Radio and Television Works, Coventry

GEC 26

EE 8196 *for further details*

BOLTON'S

H.C. COPPER

STRIP, SHEET, TAPE & FOIL

Plain and tinned; drawn, rolled, rolled and drawn, or rolled and sheared. Sheets up to 10 ft. x 4 ft. in any thickness over 1/32″; thinner sizes 6 ft. x 3 ft. or 4 ft. x 2 ft.

Annealed strip for generator and transformer windings, etc., with square or rounded corners, or with rounded edges; Bolton's specialize in the production, in suitable sizes, of long jointless lengths weighing up to 18 cwt. Hard-drawn and semi-hard-drawn strip in coils or in straight lengths; supplied in special tempers, to close tolerances, and on drums, when required. Foil down to 0.0005″ thick.

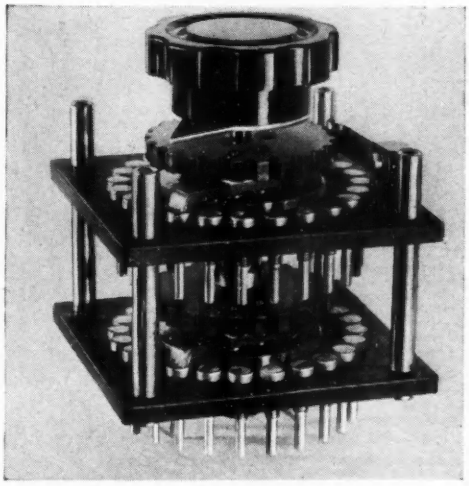
THOMAS BOLTON & SONS LTD

Head Office : Mersey Copper Works, Widnes, Lancashire.
Tel.: Widnes 2022.

London Office & Export Sales Department ;
168 Regent Street, W.1.
Tel.: REGent 6427.

PRECISION INSTRUMENT SWITCH

Type S.P.I.



These switches are designed for use in conditions where robustness, reliability, low contact resistance and long service are required. They are intended primarily for use in precision resistance units, strain gauge selection, and thermocouple work.

The $\frac{1}{16}$″ diameter stud contacts are made of hard copper and the multileaf self cleaning brush is phosphor bronze.

Standard types single or multi-pole at an economic price in a large variety of forms available from stock.

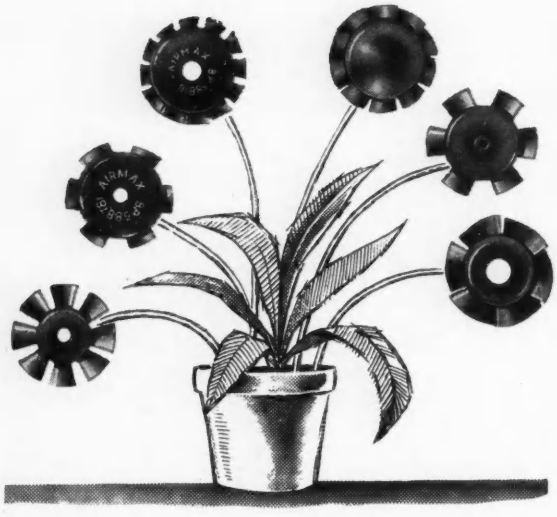
★ **LOW INVARIABLE CONTACT RESISTANCE**
★ **NEGLIGIBLE THERMAL E.M.Fs.**
★ **MULTI-POLE TYPES AVAILABLE**

For full details please request leaflet No. 64.

CROYDON PRECISION INSTRUMENT CO.

HAMPTON ROAD . WEST CROYDON . SURREY *Telephone:* **THORNTON HEATH 4025**

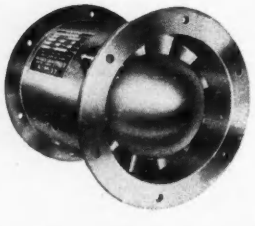
EE 8198 *for further details*



Ventilation Plant

The wide range of Airmax rotor designs enable the Airmax pressure fans to be used for a variety of industrial ventilating purposes. These fans are available with various motors, and suitable rotors are fitted to meet the particular pressure ratio required.

The simplicity in design and robust construction ensure a trouble free life. This Airmax 4″ model requires no maintenance.



Please write for details of this 4″ and other fans from:

Airmax

patented

A. K. FANS LIMITED
20 UPPER PARK RD. · LONDON · N.W.3.
Telephone: Primrose 5969

A.I.D. A.R.B.

E.I.A. S.B.A.C.

THE SYMBOL OF SERVICE

We have immediate capacity for:—

Electronic wiring & assembly
Sheet metal work
Precision engineering
including specialist welding in
ferrous & non-ferrous alloys

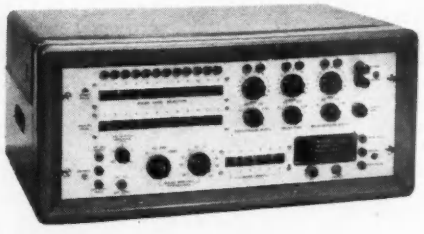
GIVE US A RING FOR PROMPT PERSONAL ATTENTION, FOLLOWED BY KEEN DELIVERY DATES

VANDYKE ENGINEERING LTD.

HARLOW, ESSEX. **Harlow 24652**

PROGRAMMED PULSE GENERATOR

Generates a train of instantly programmed pulses of variable pulse spacing and variable pulse width, both at a direct pulse position and at delayed intervals



Technical Specifications

1.	Pulse spacing:	8—100,000 microseconds		
2.	Frequency range:	10—125,000 cycles		
3.	Word length variable:	1—64 digits		
4.	Pulse width:	1—150,000 microseconds		
5.	Pulse selections:	Up to 24 pulses per word		
6.	Outputs:	*Voltage*	*Impedence*	*Rise Time*
	A—Combined Output:	20 volts	1000 ohms	0.5 microseconds
	B—Direct Output:	30 volts	6800 ohms	0.5 microseconds
	C—Delayed Output:	30 volts	6800 ohms	0.5 microseconds
7.	Power Supply:	210-240 volts, 50-70 c/s (200 watts)		
8.	Dimensions:	Standard 19 in. panel, 7 in. high, 10 in. depth		
9.	Valve Complement:	3 CD6	1 OB2	1 6AU6
		15 12AU7	1 12AX7	1 6CH6
		3 12AT7	3 5965	
10.	Magnetic Binary Units:	1 MB450 (Pulse Generator)		
		6 MB231 (Scaler)		
		12 MB5713 (Shift Register		

Price : £357.12.0 ex-works. **6/8 weeks.**

LINTRONIC LTD.

47, CHARING CROSS ROAD, W.C.2.
Tel.: GERrard 5509 FULham 8204

First in the field!

WITH SIT-DOWN SHOTBLASTING . . . .

This new Sit-Down Shotblast Machine is way out in front. Designed for day long blasting it is particularly suitable for female operators, eliminating fatigue and increasing production. Already installed by leading industrial establishments and proved beyond doubt a time saver and a production asset, we have no hesitation in recommending the new SBP/41 Shotblast Machine to all manufacturers requiring to clean, de-rust, de-scale and matt-finish metal prior to metal spraying, painting etc. What more could you wish for ?

BY GUYSON — IT'S GOOD

Send for Leaflet SBP/41 (A) today.

See us at Stand No. 6, Engineering Exhibition, inner row gallery, Grand Hall, Olympia, April 16th-30th

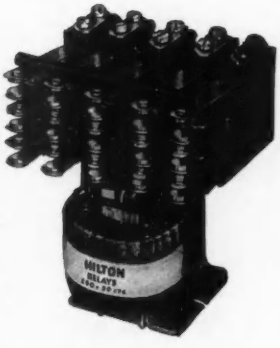
Guyson Regd.

GUYSON INDUSTRIAL EQUIPMENT LTD.
North Avenue, Otley, Yorks. Tel. 2456

HILTON | **Timers** | **Delay Relays** | **Relays**

ELECTRONIC PROCESS TIMERS FOR AUTOMATION

EFFICIENT, COMPACT AND ECONOMICAL



FOR INFORMATIVE SWITCHING AND POWER HANDLING

AIDS TO PRODUCTION

HILTON ELECTRIC CO. LTD.

CHURCH ST · WOLVERHAMPTON

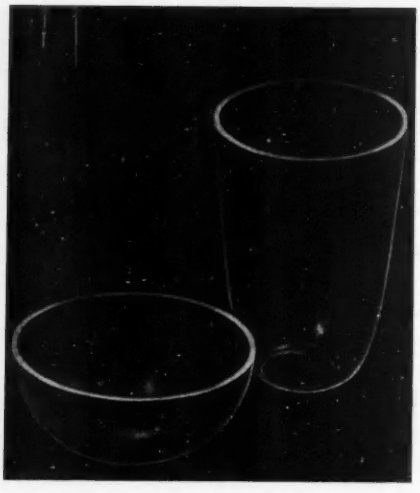
PHONE 22783

EE 8204 *for further details*

HPQ

VITREOSIL FUSED QUARTZ

FOR SEMI-CONDUCTOR WORK



High purity fused quartz (H.P.Q.) boats, crucibles and tubes are available for preparation of hyper-pure silicon. They have an exceedingly low content of boron, aluminium and other elements detrimental to semi-conductors.

We also manufacture an extensive range of Vitreosil Industrial Ware

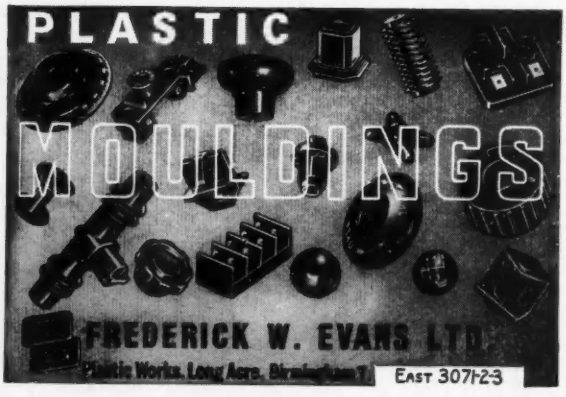
THE THERMAL SYNDICATE LTD.

TSL

P.O. Box No. 6
WALLSEND, NORTHUMBERLAND
Telephones : Wallsend 6-3242

LONDON :
12-14, Old Pye St., Westminster, S.W.1
Telephone : ABBey 5469

EE 8205 *for further details*



EE 8206 *for further details*

***STABILIZE** YOUR AC MAINS with the finest equipment, at a fraction of the normal cost :—*

FERRANTI 7½-KVA MOVING COIL AUTOMATIC VOLTAGE REGULATORS

Any stabilized output voltage in the range 200-250V can be selected by plug-board tappings. The selected output voltage is automatically maintained constant within ±½%, at all loads 0 to 30/37½ amps, when the supply voltage is varying over the range +8% to −12%.

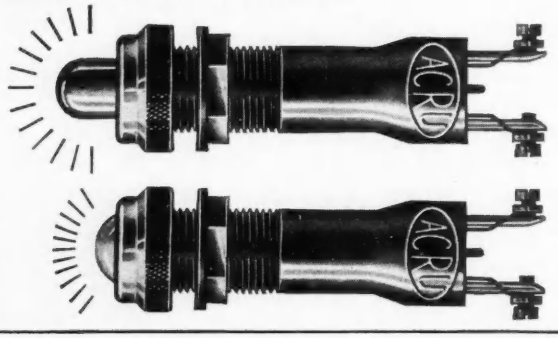
- Frequency compensated 45-55 and 54-66 c/s.
- Excellent output wave-form.
- Can also be used as a variable transformer.
- ***Unused.*** Complete with spares and Instruction Book.

P. B. CRAWSHAY,
94, Pixmore Way, Letchworth, Herts. 'Phone 1851.

ACRU NEON INDICATOR LAMPS

Used by most Electronic Engineering firms throughout the world.
Supplied with one-hole fixing.
Average life 25,000 hours.
There are over twenty-five models.
Voltages from 60 to 440.

Ask for details of our new S.E.S and M.C.C. fittings.



ACRU ELECTRIC TOOL MFG. CO. LTD.
Acru Works, Demmings Road, Councillor Lane, Cheadle, Cheshire. *Tel., GATLEY 6058*

EE 8207 *for further details*

EE 8208 *for further details*

NEW—Taylormeter 100A Model

SUPER-SENSITIVE!! **UNIQUE!!**

WORLD'S FOREMOST!!

100,000 o.p.v.

OUTSTANDING FEATURES:

Sensitivity 100,000 o.p.v. D.C., 5,000 o.p.v. A.C.
Current readings from 0.2 microamps—10 amps. D.C. (10μA, 50μA, 250μA, 1mA, 100mA, 1 Amp, 10 Amps).
D.C. Volt readings from 10mV—2,500V (25kV by probe) (0·5, 2·5, 10, 25, 100, 250, 1,000, 2,500)
A.C. Volt readings from 0—2,500V. (10, 25, 100, 250, 1,000, 2,500)
Ohms from 0—200 megohms in 4 ranges (self-contained).
5 Decibel Ranges.
5 Output Ranges. **Many other advantages.**
Accuracy 2% D.C. 3% A.C. 5% Ohms.
5" Mirror Scale meter.
Automatic Mechanical Cut-out effective on all ranges.
Reverse Polarity facility.
Robust and suitable for everyday use.

HIRE PURCHASE OR CREDIT SALE TERMS AVAILABLE

TRADE PRICE **£26.15.6**

See this and the full range of Taylor Instruments on **Stand No. 86** at the **R.E.C.M.F. Exhibition, April 6—9**

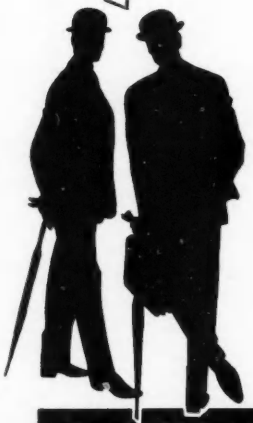
Taylor

Write for full details

NOW AVAILABLE! New edition of VALVE MANUAL FOR TAYLOR TESTERS
Gives over 5,000 settings and characteristics Price 7/6 post free

TAYLOR ELECTRICAL INSTRUMENTS LTD.
MONTROSE AVENUE · SLOUGH · BUCKS. *Telephone - Slough 21381*

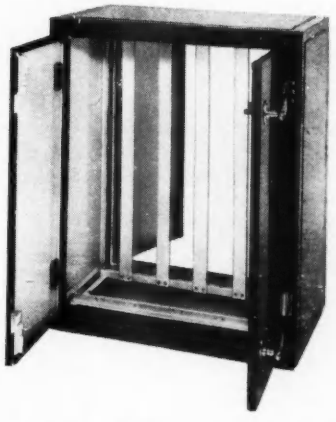
Fabrication? take my advice — see Spencers!



"Quite frankly, you'll find Spencer's hard to beat when it comes to special fabrications—be they in mild or stainless steel, or light alloys.

"Spencers have a breadth of experience which gives them a versatility and flexibility which is mighty useful to such as you and me. You see, a problem solved for a customer in one field often helps the solution of a quite different problem in some other direction.

"No matter what fabrication problem we've had, somehow Spencers have always come up with the answer. Can you wonder I advise *you* to get in touch with them? Believe me, a job done by Spencers is a job *well* done"



Typical of the scope of our service to industry is this cabinet for switchgear and many types of electronic instruments.

This particular cabinet was made as a switchgear cabinet for a large Electrical Engineering concern in the Midlands, but sizes and styles of such cabinets can be developed to suit customers requirements.

SPENCER & SONS (MARKET HARBOROUGH) LTD.

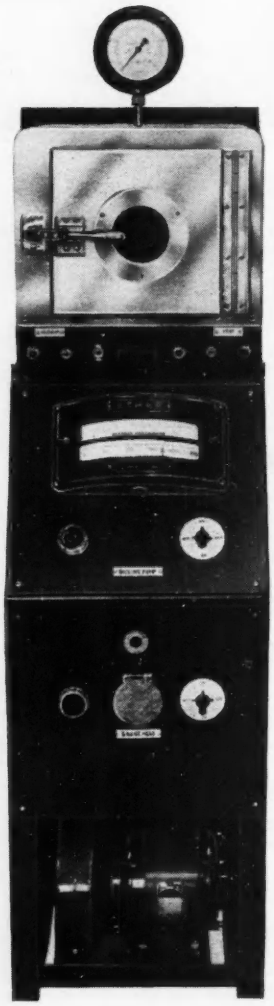
Fabrications in Steel and light Alloys

SPENCER & SONS (Market Harborough) LTD., GREAT BOWDEN RD., MARKET HARBOROUGH **Tel. 2651/2**

EE 8209 *for further details*

EE 8210 *for further details*

VACUUM OVENS
DOUBLE ENDED



- Made throughout in polished stainless steel.
- Single action door openings
- Rectangular with shelf spacings to suit.
- Double ended controls.
- Electrical interlocking of air inlet and isolation valve.
- Outer cover hermetically sealed.
- Temperature Range 0°—300°C or equivalent F.
- Temperature Control: Normal ±7½°C. Special ±1°C.
- Internal Spacing 7″×8″×18″ (can be altered to special requirements).
- Vacuum Range to 10-4 mm.
- Respective Vacuum Gauges incorporated.
- Automatic air inlet valve backing Pump.
- Visual Indicators and fuses on all switches.
- Flanged for fitting into Dry Box.

VACWELL ENG. CO. LTD.

We design and manufacture Ovens to Customers' special requirements. Should you have any problems in this field, our Technical Department is always willing to help you solve them.

Vacuum Ovens with temperature of up to 600°C are also manufactured by us on similar lines but with Sectional Heating and Water-Cooled Ends.

VACWELL ENGINEERING CO. LTD.
WILLOW LANE, MITCHAM, SURREY
Tel: MITcham 8211

SPECIALISTS IN DESIGN & MANUFACTURE OF VACUUM EQUIPMENT

EE 8211 *for further details*

Insuloid sas
Adjustable Cable Rack Saddles

Secure Cables at 2 POINTS with only 1 SCREW

Yes . . . every type, every size and every combination of cables are secured slickly, quickly and more efficiently than ever before with these Insuloid 2-point fixing Single Screw Adjustable Saddles. Designed for use with standard cable racking, the SAS Saddles are made from tough, virtually unbreakable, nylon to withstand the effects of most chemical and acid attacks, and providing for high insulation value, freedom from corrosion and electrolytic action. Leading users say "These Insuloid SAS Saddles are superb."

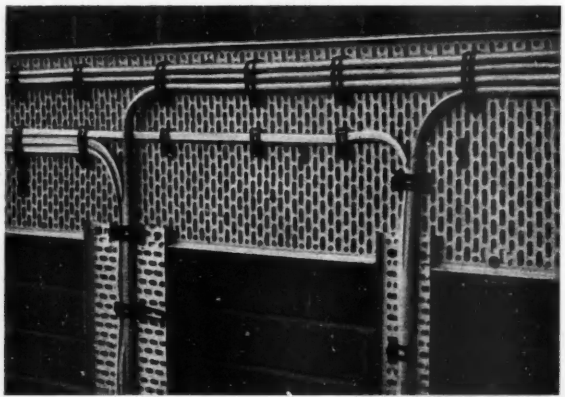
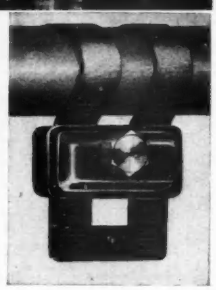


Illustration shows a portion of a typical SAS Saddle installation.

LOOK AT THESE ADVANTAGES

- *Two stock sizes secure all diameters and combinations of cables.*
- *No need for special Saddles to be made on site.*
- *Self-tensioning, anti-corrosive, high insulation value.*
- *Permits later additions or removals of cables.*
- *Cuts assembly time by 50%.*
- *Unbreakable in service.*



** A big brother has arrived To fulfil many requests, INSULOID announce the addition of SAS 2 . . . a larger capacity Saddle . . . they're ready NOW!*

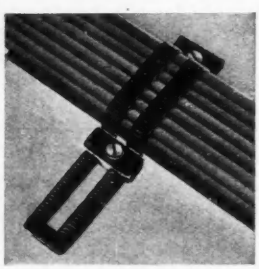


Illustration above shows how the complete AS Strap can be left uncut if future extensibility is required.

Insuloid as
Adjustable Saddles

Designed specially for wall and panel mounted wiring installations. The Insuloid AS Saddles have all the outstanding virtues of SAS Saddles, and three sizes only are required to cover even the most complex wiring assembly and at the same time considerably reduce time and costs, in addition to providing complete security with the highest insulative, anti-corrosive qualities in every climatic condition.

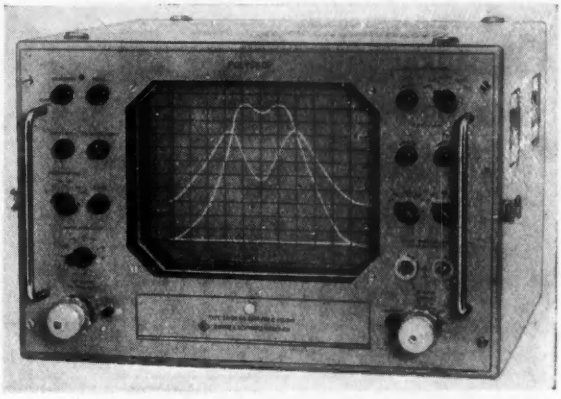
Fully descriptive literature on the Insuloid SAS Adjustment Saddles and AS Adjustable Saddles will be sent to you promptly at your request.

INSULOID MANUFACTURING CO. LTD.
Sharston Works,
Leestone Avenue, Wythenshawe, Manchester
Telephone: Wythenshawe 2842 & 3163

COME AND SEE US ON STAND Q4 AT THE A.S.E.E. EXHIBITION · EARLS COURT

Polyskop

A NEW ROHDE & SCHWARZ INSTRUMENT



TWO CHANNELS: WIDE BAND SWEEP
RF GENERATOR AND CRT DISPLAY
FREQUENCY RANGE 500 Kc/s to 400 Mc/s
SWEEP WIDTH ±200 Kc/s to ±50 Mc/s

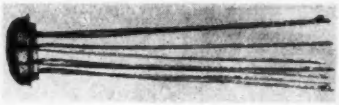
For direct viewing of impedance, gain or attenuation versus frequency in Aerials, Filters, Amplifiers, Cables.
11″×8″ Screen, illuminated grating
Two probes for Roving Tests.
Crystal controlled Markers: 1—10—50 Mc Points.

SHORT DELIVERY: DEMONSTRATIONS AVAILABLE

AVELEY ELECTRIC LIMITED
15/16, AYRON ROAD, SOUTH OCKENDON, ROMFORD, ESSEX. *TEL: SOO 3444*

CORES

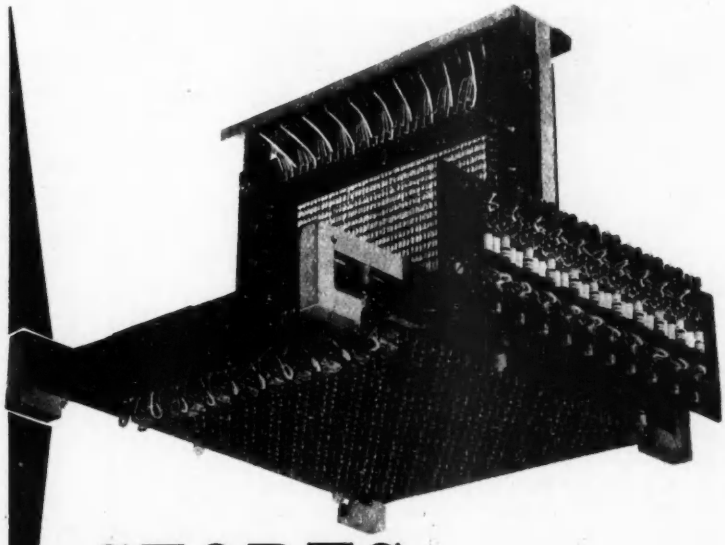
We specialise in the large scale production of all types of miniature toroidal coils wound on cores of down to 50/1000″ diameter. (as shown below).



50/1000″ OUTSIDE DIAMETER

Actual-size photograph showing one of our small ferrite ring cores mounted on glass base and encapsulated in resin. This particular core carries four windings of 20, 10, 10 and 5 turns of 48 s.w.g. enamelled wire.
Coils such as these are manufactured entirely in our Newport Pagnell factory.

For full details write to:—



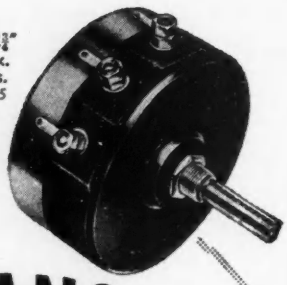
STORES

In addition to the manufacture of coils and components we undertake the assembly of complex equipment such as this unusual Matrix Store for a 100-channel Analyser shown above.
(As supplied to Sunvic Controls Ltd.).

NEWPORT INSTRUMENTS (Scientific & Mobile) LIMITED
NEWPORT PAGNELL · BUCKS · ENGLAND
Telephone: Newport Pagnell 401/2

EE 8213 *for further details*

EE 8214 *for further details*



PIW Dia. 2¾"
20 Watt Max.
Range 1-500,000 ohms.
Data Sheet No.5

from the famous range of

RELIANCE

POTENTIOMETERS

Between the latest miniature type 'MW' and the heavy duty type 'PIW' is a range of models that completely meets the exacting demands of today's electronics and automation.

The standard 'RELIANCE' range covers from 1 to 500,000 ohms and includes linear, log, semi-log and non inductive types, and depending on characteristics ratings up to 20 watts.

RELIANCE MANUFACTURING CO. (SOUTHWARK) LTD.

SUTHERLAND ROAD · HIGHAM HILL
WALTHAMSTOW · LONDON · E.17
Telephone: No. (and cables) LARkswood 3245

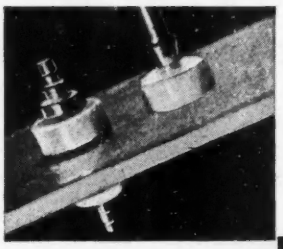
MW Dia. 29/32"
1 Watt Max.
Range 5-50,000 ohms.
Data Sheet No.1

G.D.12

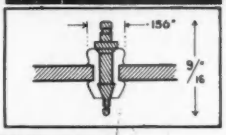
EE 8216 *for further details*

THE P.T.F.E. "BARB" LEAD-THROUGH

(Type 156)



A new compact lead-through, speedy to assemble, and of outstanding physical characteristics. *Patent applied for.* The polytetrafluorethylene bush, which is supplied with the heavily silver-plated brass barb partly inserted, is positioned in a hole .156" in dia. Firmly pressing the barb through the assembly expands the P.T.F.E. bush on the far side of the chassis and locks it firmly in position.



VOLTAGE 3kV working voltage for laboratory use. 1kV under tropical conditions.
CAPACITY Less than .75mmF.
TEMPERATURE –55 C. to +200 C.
RESISTANCE TO PULL in either direction 20 pounds.
CHASSIS THICKNESS, recommended for 1/16".
CHASSIS HOLE, .156" diameter
Enquiries invited for other dimensions and types.

OXLEY

DEVELOPMENTS CO. LTD.
ULVERSTON NORTH LANCS Tel Ulverston 3306

Rainbow

currently manufacturing a wide range of Electronic Equipment, including "UNILAB" Instructional Aids, "DUMEC" T.V. Distribution Amplifiers, and "BOWJECTION" Front Projection Television, now desire to expand these and similar fields and would welcome enquiries for sub-contract work or complete manufacture under an established or a new Trade Mark.

We have a very well equipped test department and would be prepared to install specialised plant for a suitable project.

enquiries in confidence to C.G. Clark
Technical Director

RAINBOW RADIO MFG. CO., LTD.

Mincing Lane, Blackburn, Lancashire

Telephone: Blackburn 4388

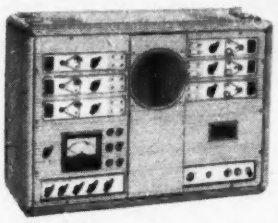
EE 8215 *for further details*

TRANSISTORS
GERMANIUM DIODES and QUADS
COPPER OXIDE RECTIFIERS and MODULATORS

WE invite YOU to meet US on the
TE-KA-DE
STAND No. 57
at the INTERNATIONAL TRANSISTOR EXHIBITION
EARLS COURT
MAY 21st - 27th

NEOFLEX LTD.
123A NEASDEN LANE,
LONDON · N.W.10
Gladstone 27118 - 4075

EE 8217 *for further details*



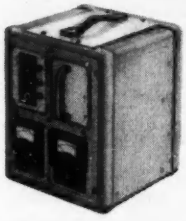
6 CHANNEL C.R.T. FILM RECORDER

We have the measure of ...recording

LOADS · PRESSURES DISPLACEMENTS

For the simultaneous permanent recording onto film, for subsequent analysis, of up to six physical variables, e.g.:—

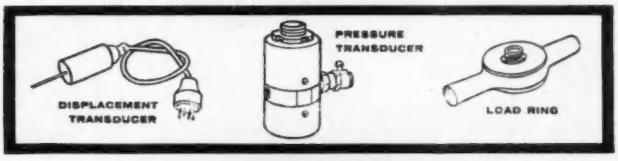
LOAD, FORCE, STRAIN,
DISPLACEMENT, PRESSURE,
ACCELERATION, TORQUE,
VIBRATION, etc.

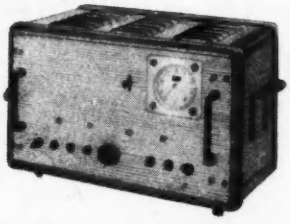


SINGLE-CHANNEL PENDEFORD SET

For measuring and indicating (up to 6 channels)

DRAW BAR PULL, GUY WIRE TENSION,
SHAFT ECCENTRICITY,
THICKNESS, TENSILE CREEP,
STRAIN IN MACHINE MEMBERS,
TENSILE LOADS,
FLUID OR GAS PRESSURE,
TORQUE, etc.





HIGH PRECISION AUTOMATIC MANOMETER

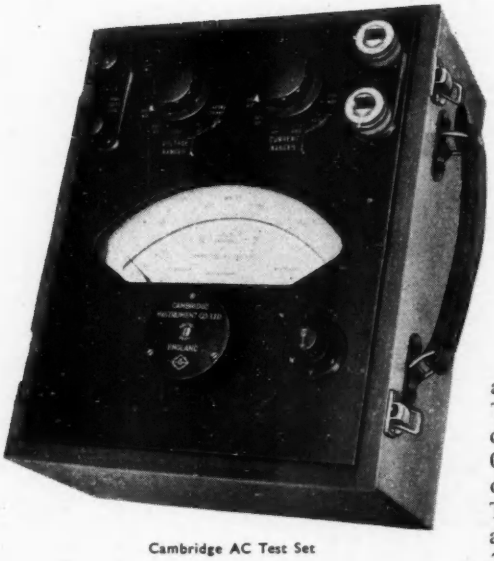
For the measurement of pressures from a few inches water gauge up to 100 pounds per square inch, to an accuracy of one part in ten thousand of the full-scale range.

BPA Electronics

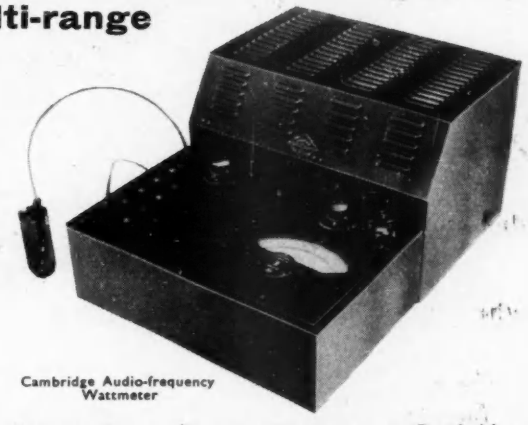
for measurement and control

ROULTON PAUL AIRCRAFT LIMITED · WOLVERHAMPTON

Electrical measurements by multi-range precision instruments



Cambridge AC Test Set



Cambridge Audio-frequency Wattmeter

For voltage, current and power measurements, Cambridge AC Test Sets and Audio-frequency Wattmeters are unique.

The combination of multiple ranges and precision grade accuracy is not often available in a single instrument. The AC Test Set is made in three models with various ranges of voltage, current, and power the outside limits being 10 volts; 500 volts; 0.5 amps; 30 amps; 5 watts; 12,500 watts. Internal power consumption is low.

The Audio-frequency Wattmeter measures AC voltage, current and power consecutively at all frequencies between 50 c/s and 20 kc/s.

Write for List AN163. For further publications write for Mailing Form AN/3/59.

CAMBRIDGE INSTRUMENT CO. LTD. 13 GROSVENOR PLACE, LONDON, S.W.1

EE 8220 *for further details*

THE

"54"

DRAWER UNIT

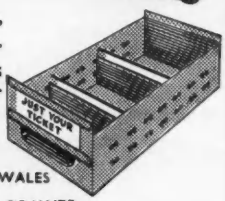
ALL STEEL Stove Enamelled DARK GREEN

•

OVERALL SIZE
42" HIGH
36" WIDE
12" DEEP

•

Contains 54 of these drawers, each 5" wide 3" high 11½" long. 54 dividers and 54 drawer cards with each unit. Extra divider 6d. each.



£18 DELIVERED FREE to ENGLAND, SCOTLAND AND WALES

SEND FOR SAMPLE DRAWER

N. C. BROWN LTD.

EQUIPMENT WING . HEYWOOD . LANCS.

Telephone: Heywood 69018 (6 *lines*)

Have you considered *Seriously* where you could use PLASTICS?

These are features of our Mouldings it will pay you to know about.

100% inspection.
Accurate to tolerances of +·002"—NIL.
A.I.D. Approval.
Uniform Quality.
Freedom from faults.
Competitive prices.

★ *Our Technical Advisory staff will be pleased to call on you and assist you in a Technical capacity.*

BRITISH PLASTICS DEVELOPMENTS LTD.

MILL LANE, PARKGATE nr. DORKING, SURREY. Tel: NEWDIGATE 317/8

EE 8221 *for further details*

EE 8222 *for further details*

MAGSLIPS

For delivery ex stock from:— SERVO AND ELECTRONIC SALES LTD., 1, HOPTON PARADE, STREATHAM HIGH RD., LONDON, S.W.16. Tel: STReatham 6165

Transmitter	AP1372 AP6547	AP10428 AP10852 AP11101 AP10456	AP10855 AP11100	AP6550	AP10965	AP10738
F.T.S. Transmitter						
SY-L Transmitter		AP10637		AP10638	AP10866 OS3713A	AP11123
Coincidence Transmitter	AP10429		AP10636	AP10682	AP10739	AP11112
X-CO Transmitter		AP10747			AP10952	AP10954
F.T. Transmitter	AP10687		AP10689	AP10741	AP10742	AP10742M
Hunter incdg.	AP3946	AP6548B	AP10854			
S.A. Hunter	AP6548	AP10731	AP10865	AP10645	AP10732	AP10872
M.C. Hunter	AP6548A	AP10735	AP10938	AP10646	AP10870	AP10964
SY-L Hunter	OS1901A	OS1902A				
Resolver	AP10640 AP10858	AP10859 AP10860 OS3423A	AP10861 AP10966		AP10874	
Receiver				AP6549		AP6549A
Motor and Generator	AP10642 AP10940	AP10643 AP10957	AP10862	AP10743	AP10877	OS3255A

MANY OTHER TYPES AVAILABLE. YOUR ENQUIRIES ARE WELCOMED
SERVO SYSTEMS AND COMPONENT BROCHURE SENT ON REQUEST

EE 8223 *for further details*

PHIL-TROL SOLENOIDS

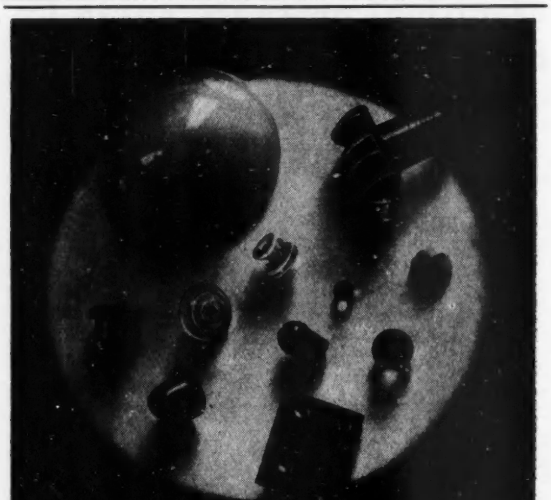
Range covers types 41 and 42 (front 1" × 1½") 38, 39 and 40 (front 1⅛" × 1¼") and power A.C. and D.C. sizes up to 650 inch-lbs.

6 v-460 v A.C. and D.C. types

QUICK DELIVERY
Solenoids are normally despatched same day as receipt of order.

PHILLIPS CONTROL (G.B.), LTD.

Dept. G7, Farnborough, HANTS. *Tel: Farnborough 1120*



- INDICATOR GLASS DOMES, MINIATURE TO 2" DIAMETER
- PRECISION GLASS MOULDINGS • SEALING BEADS
- PRECISION GROUND GLASS BALLS • BALLOTINI

THE ENGLISH GLASS CO. LTD

EMPIRE ROAD, LEICESTER

specialists in small glass mouldings EGC *Telephone Leicester 23481-2*

EE 8224 *for further details*

EE 8225 for further details

BRUSH QUARTZ CRYSTAL UNITS

You can rely on the BRUSH reputation for guaranteed deliveries

Quartz crystals in hermetically sealed cases or evacuated glass envelopes for frequency control and filter applications.

As supplied to all the major Airlines and Radio Manufacturers.

Technical service available to assist in formulating design specifications to customers' special requirements.

A.I.D. and A.R.B. approved.

Brochure on request.

BRUSH CRYSTAL CO. LTD. HYTHE, SOUTHAMPTON

TELEPHONE: HYTHE (Southampton) 3031-2 CABLES: BRUDEV. HYTHE SOUTHAMPTON.

a Complete Scintillation Service

phosphors and counters

PLASTIC & LIQUID PHOSPHORS

★ **PLASTIC PHOSPHOR NE 102,** light output 65% anthracene, available in all sizes and shapes up to one ton, in thin sheet form, in fine tubes for the construction of scintillation flow counters, or as filaments for the construction of scintillation nuclear track chambers. (Bulletin 11).

★ **BORON POLYESTER PLASTIC PHOSPHOR NE 400 and NE 401** (88% B^{10}) for neutron detection. Standard sizes from 0.5 to 5.0 inches diameter. (Bulletin 13).

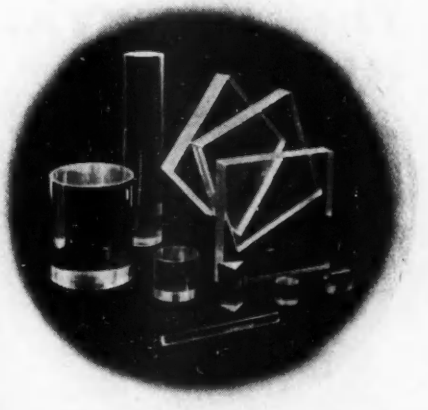
★ **LOADED LIQUID SCINTILLATORS** in bulk or encapsulated, containing Pb for extreme X-ray sensitivity, and Gd, B, Cd, and Sm for neutron detection. (Bulletins 9 and 9a).

★ **SCINTILLATING GELS** for efficient internal counting of suspended materials. (Bulletin 9).

★ **SCINTILLATION CHEMICALS** of highest purity P.B.D., POPOP, T.P.B., p-terphenyl, PPO, D.P.H., alpha-N.P.O., D.M.C., B.B.O., B.P.O., D.P.A., D.P.S., vinyltoluene, styrene, xylene, toluene, methyl borate, phenylcyclohexane, monoisopropylbiphenyl.

★ **LIGHT PIPES** of polyvinyltoluene and polystyrene.

★ **PLASTIC PHOSPHOR SPIRAL FLOW CELL NE 801** for beta and alpha emitters.



Nuclear Enterprises (G.B.) Ltd

NEW LINE OF PRECISION NUCLEAR INSTRUMENTS

★ Non-overloading Linear Pulse Amplifier NE 5202 of the Fairstein type (Bulletin 14).

★ Pre-Amplifier and Cathode Follower NE 5202A.

★ Single Channel Pulse Height Selectors NE 5102 and NE 5103.

★ Shielded Scintillation Head Units NE 5501-3.

★ Highly Stabilised EHT Supplies NE 5302 (1.8 kV) and NE 5303 (5 kV).

★ Complete assembly for C^{14} and tritium counting NE 8301.

★ Complete Human Body Counter Installations NE 8101-3.

★ Ratemeter NE 5401 with eight ranges and six time constants.

★ Scanning scintillation spectrometer NE 8601.

BANKHEAD MEDWAY, SIGHTHILL, EDINBURGH, 11 SCOTLAND — Tel: CRA 4513

OF SPECIAL NOTE

★ **SCINTILLATION CRYSTALS** by Harshaw. Exclusive concessionnaire in Great Britain for NaI(Tl), CsI(Tl), LiI(Eu), and Li^6I(Eu). NaI(Tl) available in sizes up to 9" diameter × 9" thick, and down to 0.015" thick with 0.005" Be windows for X-ray counting and spectrometry. Resolution with standard sizes 7-8% on Cs^{137} line. CsI(Tl) down to 0.005" thick for alpha and proton studies. Li^6I(Eu) in special low temperature mounts for fast neutron spectrometry.

★ **NEW!** Photomultiplier—NaI(Tl) combinations with direct coupling of crystal to photomultiplier and giving improved resolution.

★ **C.D.C. 100-CHANNEL TRANSISTORISED KICKSORTER** at new *low* price for 1959 and with short delivery. Full range of accessories to provide automated assembly.

★ **MULTI-CHANNEL SCINTILLATION SPECTROMETER NE 8201** for industrial tracer investigations. (Bulletin 15).

Write now for Bulletins and Price List.

RDR 707

EE 8226 for further details

EE 8227 *for further details*

ELECTROPLATERS TO THE ELECTRONIC INDUSTRY

Specialising in **RHODIUM, SILVER, GOLD** and **HARD GOLD** plating of Electronic Components.

ATLAS SATIN CHROME

Is well established as the Ideal decorative finish for instrument parts. It has a pleasing colour which is durable and is easily cleaned.

ATLAS ELECTRO BLACK

This finish in Matt, Semi-bright or Fully Polished provides an excellent contrast to the Atlas Satin Chrome.

APW

ATLAS
PLATING WORKS LTD.
Avenue Rd., Acton, London, W.3
Telephone : ACOrn 1102

A.I.D., A.R.B. & I.A. approved.

EE 8229 *for further details*

All Types of

EXTERNAL & INTERNAL
MICROMETERS

HEIGHT GAUGES

STANDARD MICROMETER HEADS MODIFIED AS REQUIRED

SPECIAL MICROMETER HEADS MADE TO ORDER

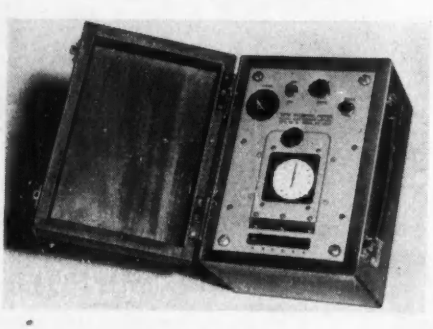
Catalogue Available on Request

SHARDLOW MICROMETERS LTD.

P.O. BOX 52.
PETRE STREET, SHEFFIELD, 4
London Office:- W. J. Bithell Ltd., 41 Whitehall, London, S.W.1.
Scottish Office:- 19 Waterloo Street, Glasgow, C.2.
A MEMBER OF THE GAUGE AND TOOLMAKER ASSOCIATION

TIME INTERVAL METER

1/10 SECOND TO 10 MINUTES BY .02 SEC.
1/10 SECOND TO 3 MINUTES BY .01 SEC.



TIME INTERVAL METER LS359-B

The "Altron" Time Interval Meter enables a stop watch to be controlled by electrical impulses, and hence by any physical condition which can be measured by electrical methods. Twelve circuit combinations are covered by the standard instrument.

The accuracy of measurement is equal to that of the N.P.L. certified stop watch.

ALLIED ELECTRONICS LTD
28 UPPER RICHMOND ROAD, LONDON, S.W.15
Telephone: Vandyke 1856

EE 8228 *for further details*

For a

COMPLETE TEST BENCH

or

SEPARATE MICROWAVE COMPONENTS

Choose

PHILIPS

X-band microwave equipment

Product of Philips Industrie, France

For detailed illustrated literature write to :

Sole Distributor in U.K.

RESEARCH & CONTROL INSTRUMENTS LTD
Instrument House, 207 King's Cross Road, London W.C.1.
Telephone : Terminus 8444

(RCL0398)
EE 8230 *for further details*

"REGALOX"

ALUMINA CERAMICS

Unaffected by high working temperature "REGALOX" remains dimensionally stable under most conditions. It holds close dimensional tolerances and concentricity. It is impervious to moisture and withstands the action of practically all chemicals. Where required, components can be high temperature metallised—a process which has already had a wide application in the Electronics field.

Let our "REGALOX" technical development advisory service tell you how "REGALOX" can be applied to your products, your production and maintenance.

'REGALOX' Test Piece sent on application

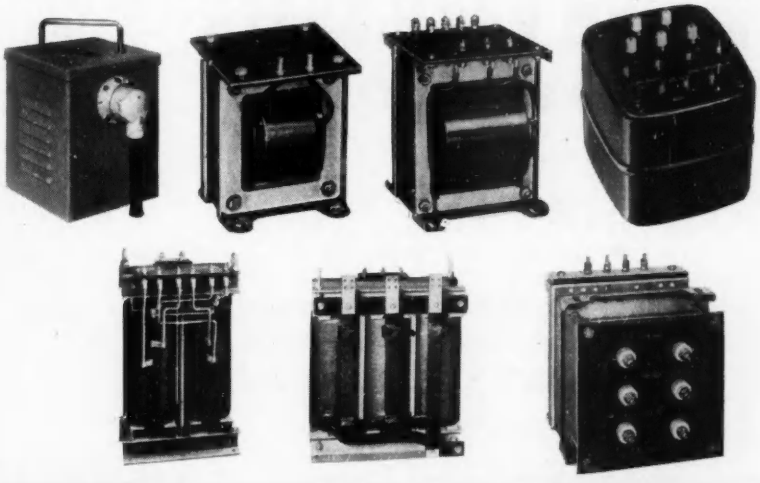
THE ROYAL WORCESTER INDUSTRIAL CERAMICS LTD.

(A DIVISION OF ROYAL WORCESTER LTD.)

Telephone: Tonyrefail 135/136 **Tonyrefail · Glamorgan** *Telegrams: "Porcelain" Tonyrefail*

"Stewart" TRANSFORMERS STL

Suitable for every type of Electronic Equipment requiring components for exacting duties under all conditions of ambient temperature and humidity.



● *Our Technical Department is at your service*

Enquiries to:—

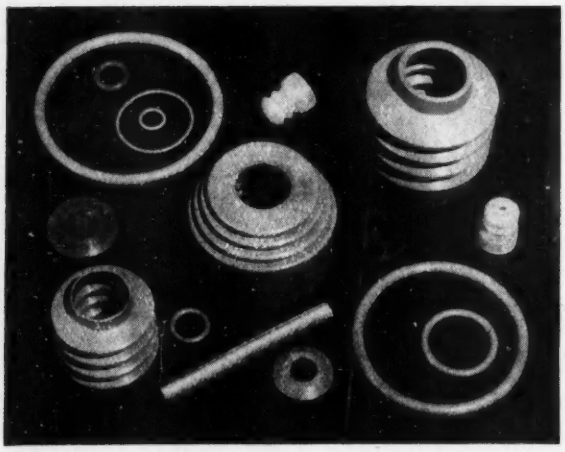
STEWART TRANSFORMERS Ltd.

KILBURN LANE, LONDON, W.10.
Tel.: LADbroke 2296/7.

WE ARE ON ADMIRALTY AND MINISTRY OF SUPPLY LISTS—A.I.D. APPROVED

EE 8232 *for further details*

EE 8233 *for further details*



SEATRIST SILICONE RUBBER MOULDINGS & EXTRUSIONS

Designed to meet industry's need for high-temperature flexible materials

For technical details write to:

Ronald Trist & Co. Ltd.

(A Company of the Bell's Asbestos and Engineering Group)

REGD. TRADE MARK

(Dept. R.9.) BATH ROAD, SLOUGH, BUCKS

Telephone: SLOUGH 25041 Telegrams: Resvalar, Slough

European TANTALUM Capacitors

- now obtainable
- no dollars
- no licence required

Also all types of HIGH-STABILITY RESISTORS.
MINIATURE ELECTROLYTIC CAPACITORS.
Complete range of all types of TRANSISTORS.

SOME SOLE AGENCIES STILL AVAILABLE

For more details apply to :-

SUPER ELECTRONICS LTD.,
5, VIOLET HILL, LONDON, N.W.8.
Maida Vale 0569

EE 8234 *for further details*

EE 8235 *for further details*

"SPINIATURE"

SUB-MINIATURE

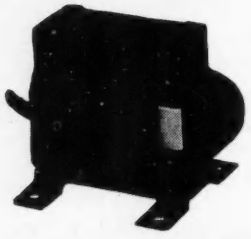
PLUGS, SOCKETS, AND SOCKET STRIPS

R.E.C.M.F. SHOW STAND No. 112

SPEAR ENGINEERING CO. LTD.
WARLINGHAM • SURREY
Tel: Upper Warlingham 2774

EE 8236 *for further details*

A. C. SOLENOID type SAM.



Continuous 14 ozs. at ¾".
Instantaneous to 5½ lbs.

Larger and smaller sizes available.

Also Transformers to 7kVA 3 Phase.

Current Transformers 100/5 to 2000/5
All classes.

R. A. WEBBER LTD.
18, FOREST ROAD, KINGSWOOD, BRISTOL Phone : 67-4065

IMPROVED
CRINKLE
SPRING WASHERS
in
BERYLLIUM COPPER
Size Range 10 B.A. to ½" B.S.F.
Satisfactorily meets the following requirements :—Corrosion Resistance, Non-Magnetic, Excellent Electrical Conductivity, High Tensile Strength up to 85 tons per sq. in., Prevents Damage to surfaces to be locked together. Made to Admiralty Signal & Radar Establishment Spec. A. 110000—Approved by RAE/RSP.318 & RCL. 224.
Supplied G.C.Q., A.I.D. or A.R.B. Released.
Prices & Samples on request.
"FORWARD"
REG. TRADE MK.
DAVID POWIS & SONS LTD.
FORWARD WORKS · SPARKBROOK · BIRMINGHAM 11 · PHONE: VIC 1264-8

EE 8237 *for further details*

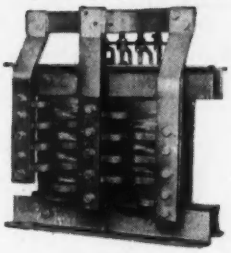
EE 8238 *for further details*

HED

PRECISION WELDING AND ELECTRICAL EQUIPMENT

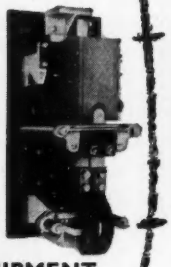
TRANSFORMERS

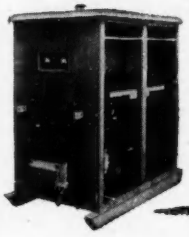
HED Transformers are designed to British Standards and to meet Ministry specifications. They embody many years of experience and understanding of customers' requirements. The range includes Transformers up to and including 200 kVA, oil- and air-cooled.



HIGH-SPEED CONTACTORS

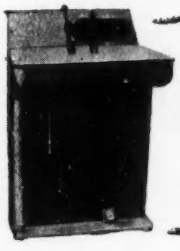
Single-pole contactors for use on AC and DC for current loads ranging from 20-1,200 amps and voltages of 500 volts AC and 125 volts DC. Can be mounted as double- or triple-pole contactors if required.





SATURABLE REACTORS

Saturable Reactors are finding an increasing application in the control of DC and AC power sources and are manufactured up to and including 200 kW. As they are completely stepless they have many advantages over other types of power controllers.

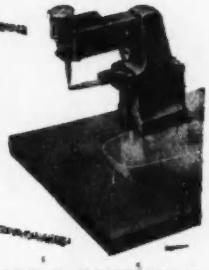


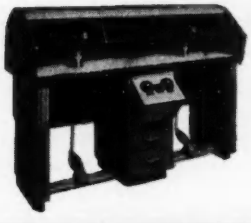
MAGNETISING EQUIPMENT

With HED ignitron magnetising equipment engineers have available large currents (up to 150,000 amps) controlled by a micro-switch triggering an ignitron valve in an electronic circuit. The pulse current is amplified by specially constructed transformers.

'BH' WELDING HEAD

This head has many uses in various industries such as Valve, Transistor manufacture, Resistances, Watches, Clocks and Meters, also for the manufacture of jewellery and in dentistry.





WELDING & ASSEMBLY BENCHES

Fitted with two 'BH' welding heads, and transformers, heat controls, tap switches, fluorescent lighting and air conditioning. Can also be supplied with single head, or for special requirements.

STAND 3 · ROW X · EMPIRE HALL, ENGINEERING, MARINE & WELDING EXHIBITION

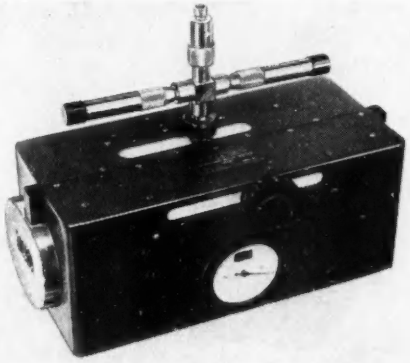
HIRST ELECTRONIC LTD

GATWICK ROAD · CRAWLEY · SUSSEX

Telephone : Crawley 25721-2-3

STANDING WAVE METERS

GRADE I—Type No. 14/3



Type No., 14/3 · Waveguide Aperture, 1.372″ × 0.622″ ±0.0006″ Type No., 14/3 · Waveguide, 1.372″ × 0.622″ · Aperture, ±0.0006″ · Flange, UG 344/U · Type, Z 830038 · Frequency Range KMc/s, 5.85-8.2 · Constancy of Probe Coupling over Carriage Travel, 0.04dB · Carriage Travel, 9 cms · Max. Refl. Coefficient, 0.001 · Variation of λg from Nominal, 0.2% · Accuracy of Indicated Probe Position 0.1%.

PRICE £355

FLANN MICROWAVE INSTRUMENTS LTD.

Scientific Instruments for Research and Education

133 Munster Road, Teddington, Middlesex

Telephone: Kingston 7217

EE 8239 *for further details*

MILTOID SALES

DIVISION

BX PLASTICS LTD.

A Subsidiary of the British Xylonite Co. Ltd.

STOCKISTS OF

BX POLYSTYRENE

Clear Crystal, Standard Commercial Quality

A first-class rigid insulating material, supplied ex stock in sheets and rods in a range of thicknesses and diameters.

•

Information and guidance on manipulation, machining and cementing available on request.

34-36 Royal College Street, London, N.W.1.

'Phone: EUSton 4146/7. 'Grams: Celudol Norwest London

T.A.7853

EE 8240 *for further details*

EE 8241 *for further details*

Muirhead

New to the family of Muirhead Oscillators, comes the D-880-A Two-Phase Low Frequency Decade Oscillator. Having a frequency range of 0.01c/s (one cycle in a hundred seconds) to 11.2kc/s, this oscillator forms part of the Muirhead Transfer Function Analyser and has many other applications in the servo-engineering field where the study of low frequencies is of increasing importance. Write for publication 130.

NEW Two Phase Low Frequency Decade OSCILLATOR D-880-A

376

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND
MUIRHEAD INSTRUMENTS INC. · 677 Fifth Ave · New York 22 · N.Y. · U.S.A.
MUIRHEAD INSTRUMENTS LIMITED · STRATFORD · ONTARIO · CANADA

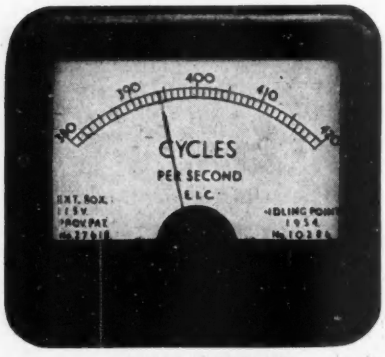
EE 8242 *for further details*

FREQUENCY METERS

SIZES : 2½" to 8"

UP TO 5000 CYCLES

PROMPT DELIVERY



also the new SYNCHROSCOPE and Phase SEQUENCE METER both up to 5Kc.

and full range of Switchboard instruments

Ask for illustrated Catalogue

THE ELECTRICAL INSTRUMENT CO. (Hillington) LTD.

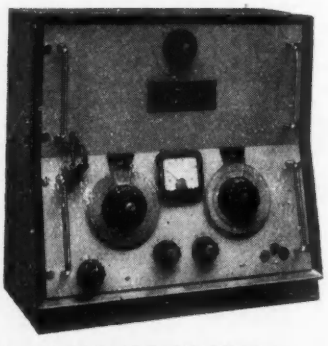
HILLINGTON GLASGOW

London stockists, H. A. Patterson & Ptnrs., Ltd., Oxford House, 23 West Wycombe Rd., High Wycombe. Telephone : High Wycombe 2769

THERMIONIC

VALVE BRIDGE

TYPE 11



- **RAPID MEASUREMENT OF r_a, g_m, and μ**
- **INTERNAL OSCILLATOR AND DETECTOR**
- **WIDE RANGE**
- **ACCURACY 2%**

Send for Illustrated Brochure

TELECOMMUNICATION INSTRUMENTS LIMITED

Dept. A.E.E. Great Yarmouth, England

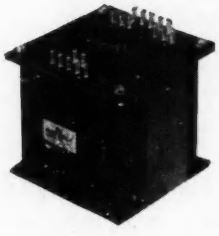
Telephone: Great Yarmouth 4941

EE 8243 *for further details*

EE 8244 *for further details*

A reputation for reliability...

A good deal of everything worth-while that goes on in the Radio and Electronic Industries goes on considerably better with the help of Partridge Transformers.

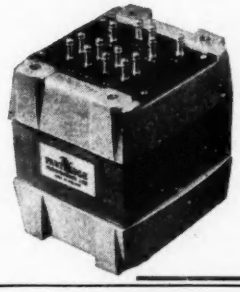


A reputation for complete reliability, skilled craftsmanship and design, backed by over 26 years experience, has made Partridge Transformers an inevitable choice for applications as diverse as the "Britannia" aircraft and the Jodrell Bank Radio Telescope shown here.

Top Left: **Style PDN,** a popular commercial range of protected Mains Transformers and Chokes.

Bottom Left: **PS000 series,** now available for a matched range of high fidelity output transformers and power transformers having a superior performance.

Right: **Style CDN,** an improved range of potted components, compound filled in robust steel cases intended for inverted mounting.



A prototype service is also maintained and one of our engineers can be at your desk to discuss your requirements within a few hours of a telephone call.

Partridge TRANSFORMERS LTD.

Roebuck Road,
Chessington, Surrey.
Telephone: Elmbridge 6737-8.

IF IT

ROTATES OR RECIPROCATES MECHANICALLY OR ELECTRICALLY

COUNT ON . . .

TRUMETER

COMPANY LIMITED

MILLTOWN ST., RADCLIFFE
Nr. MANCHESTER
TELEPHONE: RADCLIFFE 2675

C 5327

EE 8245 *for further details*

AUTOMAT

SELENIUM RECTIFIERS *to any rating*

EARLY DELIVERY OF HIGH STABILITY RECTIFIERS to any rating

AUTOMAT MOORSIDE, SWINTON, MANCHESTER
Tel: SWI. 4242

EE 8246 *for further details*

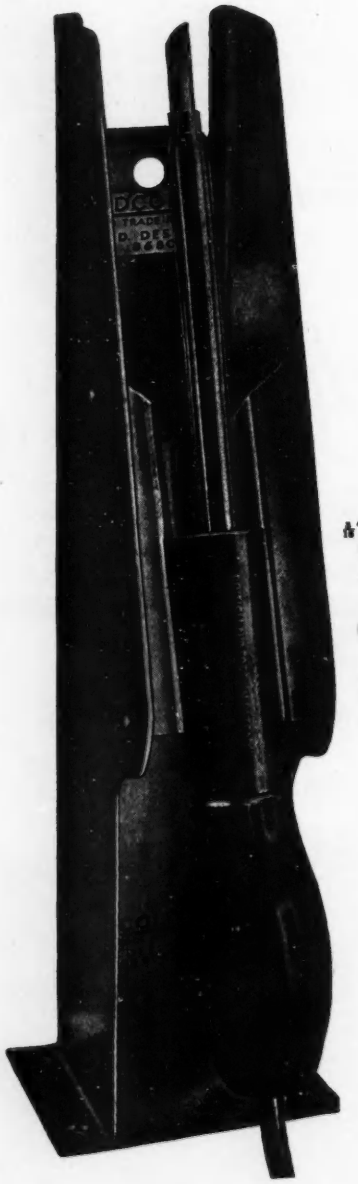
EE 8247 *for further details*

SOLDERING EQUIPMENT

by

ADCOLA

(Regd. Trade Mark)



(Illustrated)
$\frac{1}{16}$" DETACHABLE BIT MODEL
(List No. 64)
&
PROTECTIVE SHIELD
(List No. 68)

Supplied for all Voltages. *Designed for Factory Bench Line Assembly Radio, T.V., Deaf Aid etc.*

Write for Catalogues

Sole Proprietors and Manufacturers

ADCOLA PRODUCTS LTD.,
GAUDEN ROAD, CLAPHAM HIGH STREET, LONDON, S.W.4
Telephone: MACaulay 3101 & 4272

EE 8248 *for further details*

PERMAFLON

is

P.T.F.E. (polytetrafluoroethylene)

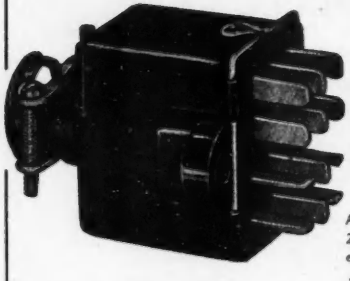
plus

PERMALI *Service*

This remarkable new plastic—heat and chemical resistant and with exceptional dielectric and non-stick characteristics—can be supplied in any shape or mouldings, or sintered to metal components.

Write *now* for full details

PERMALI
LIMITED
Specialists in Insulating Materials
Gloucester England
Tel: Gloucester 24941



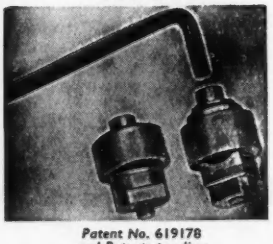
SOLE LONDON DISTRIBUTORS of

ELCOM

MINIATURE MULTI-WAY PLUGS AND SOCKETS

A full range of connectors from 2 to 33 way, proven in use by the electronic industries of the world

"Q-MAX" CHASSIS CUTTERS



Patent No. 619178 and Patents pending

The easiest and quickest way of cutting holes in **SHEET METAL.**

		each
$\frac{1}{4}$" or $\frac{5}{16}$"	(a)	12/9
$\frac{3}{8}$" or $\frac{7}{16}$"	(a)	13/9
1", 1$\frac{1}{8}$" or 1$\frac{1}{4}$" ...	(b)	16/-
1$\frac{3}{8}$" or 1$\frac{1}{2}$"	(b)	18/-
1$\frac{5}{8}$"	(b)	20/6
2"	(c)	30/-
2$^9/_{32}$"	(c)	33/6
2$\frac{1}{4}$"	(c)	38/6
1" square	(b)	29/-

Keys (a)—1/-; (b)—1/6; (c)—2/3.

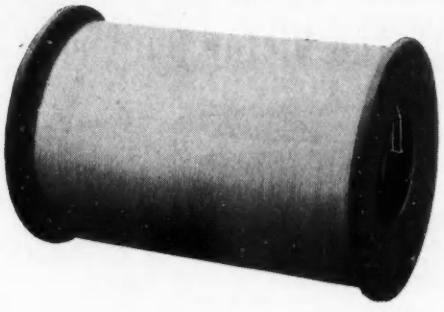
40 Page FULLY ILLUSTRATED CATALOGUE of Electronic and Hi-Fi Equipment free on application

BERRY'S RADIO
25 HIGH HOLBORN, LONDON, W.C.I.
Tel.: HOLborn 6231/2

EE 8249 *for further details*

EE 8250 for further details

Quicker Delivery



Better Quality

Lower Prices

Suflex Nylon Glass Cord
with high tensile strength, small extensibility and good wear resistance, for tuning assemblies, etc., is being produced with quicker delivery in better quality, and at substantially lower prices as a result of the installation of improved and increased manufacturing plant. Please write in for full details

SUFLEX *Limited*
LONDON

SUFLEX LTD., 35 BAKER STREET, LONDON W.1 TEL: WELbeck 0791

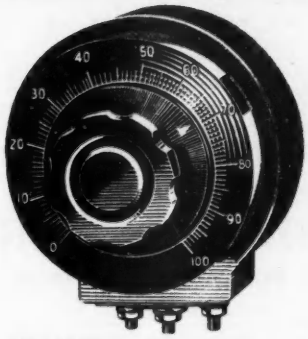
EE 8251 for further details

Consult

Birch
REGISTERED TRADE MARK

for

TOROIDAL RESISTORS



FORMER

Patented ceramic mounding with horizontal opposed copper graphite internal brush movement.

WINDING

Best quality resistance wires to B.S.S. 115.

WRITE FOR LIST NO. 130

VITREOUS ENAMELLED RESISTORS

Ferrule or wire end type:
full range of 24 sizes—1½—250 watts. List V.E. 190

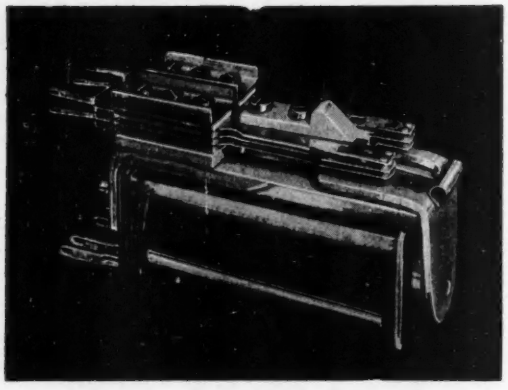
ask for

Asbestos Woven Mats.
Heating Elements.
Loading Resistors
Motor Operated Resistors
Stud Type Resistors
Sliding Resistors.

Birch
REGISTERED TRADE MARK

H. A. BIRCH & CO. LTD.
WOOD STREET, WILLENHALL, STAFFORDSHIRE
Telephone WILLENHALL 494 495 · Grams WILOHM WILLENHALL
LONDON OFFICE: 1-5 NORTHOLT ROAD, HARROW, MIDDLESEX
Telephone: BYRON 5120

EE 8252 *for further details*



RELAYS *for* TELECOMMUNICATIONS

A Quality Relay with Sensitive High Efficiency Magnetic Circuit similar to G.P.O. 3000 type. Improved design Coil Tags. Armature fixed with special clip for easy removal.

CHARACTERISTICS.

CONTACTS. Nickel Silver Springs with Silver, Silver Alloys, Platinum or Heavy Duty Elkonite Contacts as required. Up to six sets of Change-over or eight sets of Make or Break Contacts.

COIL. Resistance from 1 to 100 000 ohms. Up to three windings on one coil.

Enquiries to:

AUTOPHONE LIMITED

539/547, Wandsworth Road, London, S.W.8

MACAULAY 2381/2

EE 8253 *for furthet details*

Absolutely No Pre-Cleaning With the Victor Soldering Tool

Covered by British and World Patents.

Price £2. 2s.

* **Speed in operation**
* **Versatility**
* **Low-voltage safety and economy**

The VICTOR is *revolutionary*—it heats the work direct by gripping it with the twin arms of the tool. Simply press the button, the work instantly heats up and the solder runs. *No pre-cleaning—even of oil—is required except where the metal has been oxidised previously.* Operation is from a 6-VOLT supply.

For heavier materials and work the 6-12-volt VENUM Soldering Tool is available. Price £4 4s.

Trade inquiries invited.

ALLIED DISTRIBUTING CORPORATION LTD.
13/17 Rathbone St. London, W.1. *Tel;* MUSeum 5411

ALS.1

WITHOUT FAIL

The Whole Year Through *for 36/-*

For this small sum "Electronic Engineering" will be delivered to you on the last Friday of every month for a year. Be sure of a regular supply of the industry's leading technical journal by filling in the coupon, and either handing it to your newsagent or sending it direct to:—

Electronic Engineering

28 ESSEX STREET, STRAND, LONDON, W.C.2

I enclose 36/- as a remittance for 12 issues of "Electronic Engineering".

Name.....

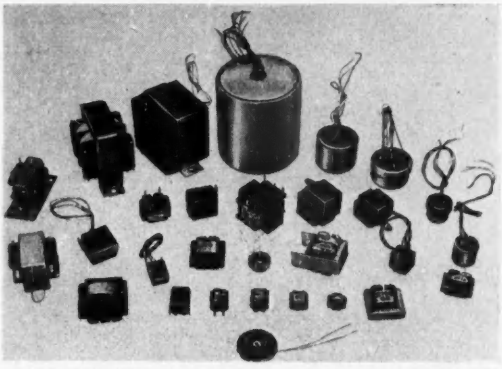
Address.....

Signature.....

EE 8254 *for further details*

FORTIPHONE
for MINIATURIZATION

APPROVED TRANSFORMER RANGE



The extensive range of Fortiphone transformers include screened, encapsulated and open types, with or without printed circuit terminations and suitable for transistor circuits, microphone matching and many other applications. Push-pull type suitable for 4.5V, 6V, 9V and 12V transistor amplifiers are available.
A full range of type approved transductor bobbins are available and complete assemblies can be produced to customers' specifications.

Granted advanced quality approval (open type transformers) advanced limited approval (encapsulated type transformers) to R.C.S.214.

For further details see the Fortiphone Transformer Handbook

FOR *MINIATURE COMPONENTS AND DEVELOPMENT AND PRODUCTION OF MINIATURE ELECTRONIC EQUIPMENT AND ASSEMBLIES · FINE WIRE WINDINGS · SMALL MOULDED, PRESSED AND MACHINED PARTS AND SUB-ASSEMBLIES*

CONSULT **FORTIPHONE** LIMITED

92, MIDDLESEX STREET, LONDON, E.1

TELEPHONE: BISHOPSGATE 0871

High Vacuum Equipment

THE NEW N·G·N CATALOGUE IS WELL WORTH HAVING

It details a full range of components and equipment specially designed for the High Vacuum Industry, and produced to the Industry's own stringent standards.

Send now for your copy to—

N·G·N ELECTRICAL LIMITED

AVENUE PARADE
ACCRINGTON

TELEPHONE ACCRINGTON 5611-2

* *Users of high vacuum equipment are invited to request a visit from Mr. H. J. Perry.*

EE 8255 *for further details*

For your cableforms and instrumentation work you cannot do better than place your requirements in the hands of the Electronic Department, Portsmouth Aviation Limited.

We will be pleased to quote you for development work or straight runs.

•

PORTSMOUTH AVIATION LTD.
(A.I.D. Approved)
THE AIRPORT, PORTSMOUTH
'Phone 62251

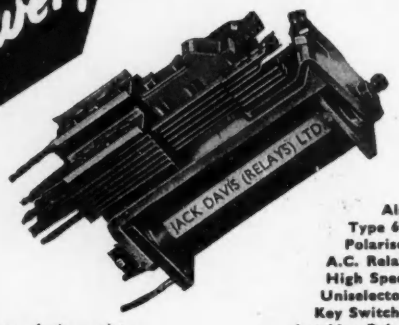
EE 8256 *for further details*

EE 8257 *for further details*

Is this the Answer?

P.O. Type 3000

The most versatile relay available today.
Coils up to 120,000Ω
Spring Set Insulation up to 5KV



Are you aware of the variety of contact build-ups we can assemble? Your problem may not be as bad as it seems if you take advantage of our wide experience in the unlimited uses of this adaptable product.

- Quotation by return
- Prototypes within 48 hours
- Good delivery guaranteed

Also
Type 600 Polarised A.C. Relays
High Speed Uniselectors
Key Switches
Latching Relays
Magnetic Counters
Miniature Sealed Relays

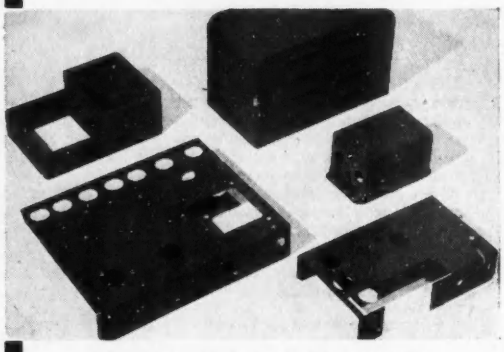
Consult the Specialists!

Jack Davis (Relays) Ltd
(DEPT 'E') TUDOR PLACE, LONDON, W.1
TELEPHONES: MUSEUM 7960 LANGHAM 4821

EE 8260 *for further details*

Manufacturers of all types of

INSTRUMENT CASES and CHASSIS in all METALS



GENERAL SHEET METAL WORK

Chase Products
(ENGINEERING) LTD

27 PACKINGTON ROAD, SOUTH ACTON, W.3
Telephone: Acorn 1153-4 *and at LEEDS*

EE 8258 *for further details*

INSULATION

Our products include—
Presspahn and Leatheroid; Pressboard; Vulcanized Fibre; Cable and Red Rope Paper; Bakelite and Ebonite; Varnished Paper and Tapes; Varnished Silks and Tapes; Varnished Glass and Tapes; Varnished Cambric, Silk, Glass and P.V.C. Sleevings; Cotton Tapes, Webbings and Sleeving; Chatterton Compound; Adhesive and Rubber Tapes; Combination Slot Insulations, Including Acetate, Tri-Acetate and Terylene.

PRESSPAHN, LTD.
BRADFORD, YORKS, ENGLAND
Established 1900

REGISTERED ELECTRICAL WELLSTEAD INSULATION TRADE MARK

Telephone: Bradford 25135 (Pvt. Br. Ex.)
Telegrams & Cables: "Presspahn, Bradford"

EE 8261 *for further details*

"A complete library in two volumes . . ."

KEMPE'S ENGINEERS YEAR-BOOK

Edited under the direction of the Editor of "The Engineer"

1959 Edition price **82/6** *(plus postage 2/6)*
from technical booksellers or direct from the publishers

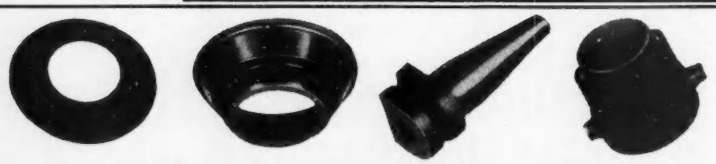
Kempe's Engineers Year-Book, 28 Essex Street, Strand, London, W.C.2 *Telephone: CENtral 6565*

THE *Dainite*
MOULDED RUBBERS SERVICE

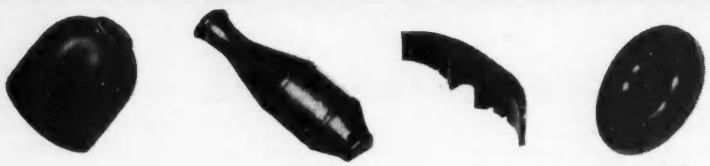
Fully A.I.D. and A.R.B. approved

Our technical staff will be pleased to advise you on your problems.

THE HARBORO' RUBBER CO. LTD.
Dainite Mills, Market Harborough. Tel: 2274 6



is here to serve ***YOU!*** *Why not make use of it!*



EE 8259 *for further details*

Electronic Engineering

READER INFORMATION SERVICE

If you would like to receive further information about any item advertised, or mentioned in the Electronic Equipment section, in this issue simply enter the appropriate reference number(s) on one of the cards opposite and post to "Electronic Engineering" (no postage stamp necessary if posted in Great Britain or Northern Ireland but overseas readers must stamp the card). We will contact the manufacturer or supplier concerned. No obligation is incurred.

Si vous désirez recevoir des renseignements complémentaires sur tout article annoncé, ou mentionné dans la section de l'Equipement Electronique, dans ce numéro, il vous suffira d'insérer le numéro (ou les numéros) de référence appropriés sur l'une des cartes ci-contre et d'adresser la carte à "Electronic Engineering" (ne pas manquer d'affranchir). Nous nous mettrons en rapports avec le fabricant ou fournisseur intéressé. Cela ne vous engage aucunement.

Falls Sie über irgendwelche Artikel die in unserem Inserat oder im Teil 'Electronic Equipment' (Elektronisches Ausrüstungsmaterial) dieser Ausgabe erwähnt sind weitere Auskünfte wünschen, bitten wir Sie die betreffende Referenznummer odernummern einfach auf eine der Karten gegenüber einzutragen und dieselbe an "Electronic Engineering" (Briefmarke erforderlich) abzusenden. Wir werden uns mit dem betreffenden Fabrikanten oder Lieferantem in Verbindung setzen. Dies ist für Sie vollständig unverbindlich.

Если читатель желает иметь более подробные сведения о продуктах, упомянутых в объявлениях или в тексте раздела "Электронное Оборудование" настоящего номера, просим отметить ссылаемый номер(а) на одной из карточек и отправить ее (оплаченной почтовой маркой) по адресу "Electronic Engineering." Мы свяжем читателя, без всякого обязательства с его стороны, с соответствующей фирмой фабрикантов или поставщиков.

Electronic Engineering

READER INFORMATION SERVICE

Please arrange for me to receive further details about the products, the reference number(s) of which I have entered below.

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

I would also like details of.....

YOUR NAME..... POSITION .....

NATURE OF BUSINESS.....

NAME OF BUSINESS.....

ADDRESS.....

.....

.....

PLEASE USE CAPITAL LETTERS

Electronic Engineering

READER INFORMATION SERVICE

Please arrange for me to receive further details about the products, the reference number(s) of which I have entered below.

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

EE..... EE..... EE..... EE..... EE.....

I would also like details of.....

YOUR NAME..... POSITION.....

NATURE OF BUSINESS.....

NAME OF BUSINESS.....

ADDRESS.....

.....

Postage will be paid by Addressee

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. 597

MORGAN BROTHERS (PUBLISHERS) LTD.,
28 ESSEX STREET,
STRAND, LONDON, W.C.2.

ELECTRONIC ENGINEERING
READER INFORMATION SERVICE

Postage will be paid by Addressee

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. 597

MORGAN BROTHERS (PUBLISHERS) LTD.,
28 ESSEX STREET,
STRAND, LONDON, W.C.2.

ELECTRONIC ENGINEERING
READER INFORMATION SERVICE

CLASSIFIED ADVERTISEMENTS

Run-on Classified—The charge for these advertisements is 6d. per word. Minimum charge, 12s. Box number, 2s. extra, except in the case of advertisements for "Situations Wanted," when it is free.
Specially Spaced Classified—42s. 6d. per single column inch.

Copy, with remittance, for the above advertisements, must be received before the 14th of the month for insertion in the following issue.

Display Classified—Full Page, £64 (based on specially spaced classified rates). Half Pages, Quarter Pages and Eighth Pages *pro rata*. Copy dates: With proofs, 5th of preceding month. Without proofs, 10th of preceding month. Blocks must be mounted.

Advertisements for publication should be addressed to:
Classified Advertisement Dept., **"Electronic Engineering," 28, Essex Street, Strand, London, W.C.2.**

OFFICIAL APPOINTMENTS

ASSISTANTS (SCIENTIFIC). Pensionable posts for men or women at least 17½ and normally under 26 on 1.1.59 with appropriate educational or technical qualifications (normally G.C.E. with passes at 'O' or 'A' level in 4 distinct subjects including English Language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 2 years' experience in either: (i) engineering or physical sciences, or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing. Starting salary (men) from £320 (at 17½) to £530 (at 25 or over). Maximum (London) £690. Promotion prospects. 5-day week generally. Write Civil Service Commission, 17 North Audley Street, London, W.1. for application form, quoting S59/59. W 3350

AUSTRALIA—UNIVERSITY OF ADELAIDE Lecturer (Electron Microscopy). Applications are invited for the above appointment in the Department of Agricultural Chemistry at the Waite Agricultural Research Institute. The Department has an active research programme concerned with the chemistry of cellular processes; an electron microscope of high resolution and X-ray diffraction equipment are about to be installed. Salary Scale: £A1,500-80-2,060, with superannuation on the F.S.S.U. basis. Potential candidates are invited to obtain from the Registrar or from the Secretary of the Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. a statement giving particulars of the post and a copy of the general conditions of appointment of lecturers in the University. Applications, in duplicate, giving the particulars stated in the last paragraph of the general conditions, and indicating when the applicant could take up duty if appointed, should reach the Registrar, the University of Adelaide, Adelaide, South Australia, not later than April 30, 1959. W 3353

B.I.S.R.A. REQUIRES Development Engineers. At the Battersea Laboratories of the British Iron and Steel Research Association, the Plant Engineering and Energy Division is engaged on the development of analogue and digital feedback control systems, information handling and methods of analogue to digital conversion for the benefit of the British Steel Industry. The work covers both heavy and light electrical engineering fields and involves the development of a wide variety of new ideas with occasional visits to steelworks for field trials. Graduate engineers are required to take responsibility for project development and the more junior positions will suit young men with O.N.C. or H.N.C. (Electrical) or equivalent qualifications. Experience in the above mentioned fields is not expected. Facilities are given to encourage further studies. Pension scheme. Canteen. Five-day week. Good starting salaries. Written applications only quoting "E.13" to Personnel Officer, B.I.S.R.A. 11, Park Lane, London, W.1. W 3368

CAMBRIDGESHIRE EDUCATION COMMITTEE. Cambridgeshire Technical College and School of Art. (Principal: D. E. Mumford, M.A.). Owing to the expansion of the College, the following appointment, additional to the present establishment, will be available from 1st September 1959: Lecturer in Electrical Engineering for Higher National Diploma and Certificate courses, and courses for Telecommunications Technicians. Graduate or equivalent qualifications in Electrical Engineering essential. Experience in Telecommunications or Electronics industries and some teaching experience desirable. Salary scale: (subject to 5% increase) £1,200 x £30-£1,350 a year. Starting position on the scale depends on previous experience. Full particulars and application forms from the Principal, Cambridgeshire Technical College and School of Art, Collier Road, Cambridge. G. D. Edwards, Chief Education Officer, Shire Hall, Cambridge. W 3370

CHIEF TECHNICIAN required to take charge of new electronic Medical Workshop at The Hospital for Sick Children, Great Ormond Street, W.C.1. Salary including London Weighting £815—£1,000. Application form and further particulars may be obtained from the House Governor. (Re advertisement—previous applications will be considered and should not be re-submitted.) W 3380

COMMONWEALTH OF AUSTRALIA. Australian Atomic Energy Commission. Applications are invited for the undermentioned position. Salary shown includes the present cost of living adjustment of £63 (A) per annum. Commencing salary will be determined in accordance with the applicant's qualifications and experience. Technical Physics Section. Research Officer (Physicist) £1,326-1,951 (A) Position R73 Duties: Conduct research into radiation detection techniques and also to develop specialised nuclear particle detectors. Qualifications: University degree with first or second class honours in Physics or equivalent qualifications with post graduate experience in radiation counter techniques. To be thoroughly conversant with the physics and construction of ionisation chambers, proportional counters, scintillation counters etc. Knowledge of high vacuum and modern laboratory techniques desirable. Applicants should include full name, date and place of birth, nationality, marital status, present position and salary, qualifications, experience, particulars of any publications and the names and addresses of at least two referees who may be contacted re technical experience, when prepared to commence and quoting the position number should be forwarded to: A.A.E.C. Liaison Officer, Australia House, Strand, London, W.C.2. not later than Friday, 24th April, 1959. W 3367

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY. Lecturer required for teaching and research in Control Engineering to work with a group concerned with the development of statistical and digital methods in relation to all types of electrical, hydraulic and pneumatic controls. Experience of digital electronic circuit techniques an advantage. Salary in scale £900×£50-£1,350, plus £60 London Allowance, F.S.S.U. benefits and Family Allowances. Apply to Head of Electrical Engineering Department, Imperial College, Exhibition Road, London, S.W.7. W 3337

INSTRUMENT ENGINEERING in Medical research. The Medical Research Council invite applications from junior engineers for a vacancy in the Instrument Laboratories at the National Institute for Medical Research. Staff in these laboratories undertake the development of specialised laboratory instruments and equipment in consultation or collaboration with various Scientific Divisions. The work is extremely varied and would be both congenial and satisfying to the right man who would require an interest in electronics, physics and general engineering. Applicants, preferably under 26 years of age, should possess an appropriate degree or City and Guilds Final (Telecomms.) or H.N.C. Salary will be on a scale: Junior Technical Officer £510×35—£660×30—£780 with prospect of promotion to Technical Officer £830—£1,150. The appointment will be superannuated and, after a provisional period of one year, established. Application forms obtainable from Personnel Officer, National Institute for Medical Research, The Ridgeway, Mill Hill, N.W.7. W 1156

MEDICAL RESEARCH COUNCIL have a vacancy for a Technical Officer at their Pneumoconiosis Research Unit, Llandough Hospital, Penarth, Glamorgan, for development, maintenance and operation of electronic apparatus. Applicants should hold the Higher National Certificate, the Final Certificate of City and Guilds of London Institute of Telecommunications, Graduate membership of the Institute of Electrical Engineers, or a University degree. Electronic experience essential. Salary on scale £800 to £1,100 per annum. Superannuation provision. Apply to Dr. J. C. Gilson, the Director, at the above address. W 3356

METAL PHYSICS AND AUTOMATION. These may seem far apart, but there are vacancies for graduate staff to work in both these fields of research in the Physics Department of the British Iron and Steel Research Association in London. We should like to hear from you if you are a graduate (preferably honours) in physics, metallurgy or electrical engineering and are keen to do research in either of these subjects. Relevant research experience would be an advantage, but we regard as essentials an enthusiasm and ability to generate and properly develop new ideas. Starting salary will be offered which is commensurate with experience and qualifications, and there are opportunities for quick advancement. Written applications only quoting "M.P.4" to the Personnel Officer, B.I.S.R.A., 11, Park Lane, W.1. W 3358

MINISTRY OF SUPPLY require a Technician at Basildon, Essex, for supervision of inspection and testing of airborne and ground radar, communication and allied equipment at a contractor's works. Quals: Recognised apprenticeship or equiv. training in appropriate trade. O.N.C., appropriate C. & G. Final Certificates or equiv. qual. desirable. Sound knowledge of electronics and also good engineering practice in Service radio equipment. Experience of inspection in industry an advantage. Salary £655 (age 26)—£820 p.a. Application forms from Ministry of Labour and National Service, Professional and Executive Register, PE.408. Atlantic House, Farringdon Street, London, E.C.4. W 3351

MINISTRY OF SUPPLY require Assistant Technical Cost Officers in London to prepare estimates of prime cost of manufacture of engineering products. These duties normally involve a fair amount of travelling. Quals.: Recognized engineering apprenticeship. O.N.C., appropriate C. & G. Final Certificates or equiv. qual. desirable. Good practical experience in ratefixing, operational planning and prime cost estimating of engineering products. Vacancies in sections concerned with mechanical and electrical productions, the manufacture of electronic equipments and work which requires good machine shop experience. Candidates selected for interview may be required to carry out a test of ability to perform these duties. Salary: £900-£1 065 p.a. Application forms from Ministry of Labour and National Service, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4, quoting PE 368. Only persons selected for interview will be advised. W 3373

MINISTRY OF TRANSPORT AND CIVIL AVIATION: requires Electrical Engineers (Assistant Signals Officers) for aviation telecommunications and electronic navigational aids. Minimum age 23, 1st or 2nd Class degree in Physics or Engineering, or A.M.I.E.E. or A.F.R.Ae.S. (candidates with Parts I, II & III of A.M.I.E.E. or Parts I and II of A.F.R.Ae.S. or equivalent, or of very high professional attainment without these qualifications considered). Salary £665 (age 23) to £1,085 (age 34) maximum £1,250. Slightly lower outside London and for women. 5 day week. Further details and forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1., quoting D.70/9A. W 3341

NIGERIAN BROADCASTING CORPORATION. Assistant Engineer-in-Charge required on contract for two tours of 18 months in first instance. Salary scale (including 15 per cent contract addition and inducement addition) £1,362 rising to £1,680. Gratuity at rate of £150 a year. Outfit allowance £60. Free passages for officer and wife. Assistance towards children's passages and grant up to £150 annually towards maintenance in U.K. Liberal leave on full salary. Candidates should preferably be Graduates of the Institution of Electrical Engineers or equivalent. They should have wide theoretical and practical experience of low frequency amplifiers, low power transmitters, audio amplifiers, communication receivers, and magnetic tape recording equipment, and be capable of maintaining and operating them. Knowledge of diesel generating plant an advantage. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/50274/EK. W 3336

OFFICIAL APPOINTMENTS (Cont'd.)

MINISTRY OF TRANSPORT AND CIVIL AVIATION: Telecommunications Technical Officers. Up to 5 pensionable posts for men at least 23 and under 40 on 1.1.59 with O.N.C. in Electrical Engineering, or equivalent standard of technical education, and at least 5 years' appropriate experience. Starting salary from £595 (at 23) to £772 (28 or over). Maximum (London) £900. Write Civil Service Commission, 17 North Audley Street, London, W.1. for application form, quoting S207/59. Closing date 14th April 1959. W 3371

PATENT EXAMINERS AND PATENT OFFICERS. Pensionable posts for men or women for scientific, technical and legal work on Patent applications. Age at least 21 and under 28, with extension for regular Forces Service and Overseas Civil Service. Qualifications: normally first or second class honours degree in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. London salary (men) £635-£1,410; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1. for application form, quoting S128/59. W 3340

ROAD RESEARCH LABORATORY (Traffic and Safety Divn.), Langley, Bucks., requires Scientific Officer Ref. A.87/8A and Asst. Experimental Officer (Physicist or Engineer) Ref. A.260/8A for work on development of electronic devices for experimental use in vehicles. Interest in or experience with transistor techniques and servo mechanisms an advantage. Quals: S.O. 1st or 2nd Hons. degree in Physics or Engineering or equiv. quals. A.E.O., G.C.E. (Advanced) in 2 science or a science and maths. subject. Over 22, pass degree, H.N.C. in Physics or Engineering, or equiv. quals. generally expected. Salaries: S.O. £615-£1,080 (men). Normal prospects of promotion to Principal S.O. in mid-thirties (salary up to £2,000). A.E.O. £377.10s. (age 18)-£825 (men). Salaries exclusive of recent 3½ per cent increase. 5 day week. Forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1. (quote appropriate reference). Closing date 10 April, 1959. W 3338

R.R.E. RESEARCH FELLOWSHIPS. Ministry of Supply invites applications for Senior and Junior Research Fellowships tenable for three years at the Royal Radar Establishment, Malvern commencing Autumn 1959. Considerable Choice of Subjects within the fields of interest to the Establishment. These include experimental and theoretical research in low temperature physics; electrical and optical properties of semi-conductors; infra-red spectroscopy; microwave physics including resonance techniques; electronics and radio astronomy. Candidates must be British with normally a First or Second Class Honours degree in an appropriate subject, with evidence of a very high standard of ability in research. Exceptionally a candidate without the requisite academic qualification, but who can produce evidence of outstanding ability in research, may be admitted. At least two years' post-graduate research experience required for J.R.F. (age preferably 23-26) and three years for S.R.F. (age preferably 26-30). Remuneration according to individual merit on ranges £1,100-£1,350 (S.R.F.) £750-£1,000 (J.R.F.) a year. Superannuation under F.S.S.U. At expiry of Fellowship the holder, if of suitable age, can be considered for an established post. Application Forms from the Director, R. R. E., Malvern, Worcestershire, to whom they must be returned by 24th April, 1959. W 3372

SENIOR SCIENTIFIC OFFICERS (a) Scientific Officers. (b) Pensionable posts for men or women in all major scientific fields, including physics, chemistry, biology, meteorology and mathematics. Age limits: (a) at least 26 and under 31, (b) at least 21 and under 28. Extension for regular Forces Service and Overseas Civil Service. Qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally for (a), at least 3 years' relevant (e.g. post-graduate) experience. London salaries (men): (a) £1,190-£1,410, (b) £635-£1,110; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1. for application form quoting (a) S53/59, (b) S52/59. W 3339

TECHNICIAN for Clinical and Research work in Cardiological Department of St. Thomas' Hospital, S.E.1. Experience in use of blood-gas apparatus and electro-manometry desirable. For full particulars apply Personnel Officer. W 3360

THE NATIONAL INSTITUTE FOR THE DEAF, Technical Department, requires a technician. The work is in connection with their programme of testing hearing aids and acoustic equipment. A knowledge of electronics and Laboratory experience are required. Salary scale: £720×£25—£820. Superannuation. Applications in writing to The Secretary, National Institute for the Deaf, 105, Gower Street, London, W.C.1. W 1154

UNIVERSITY MEDICAL SCHOOL requires an Electronic Engineer to work with psychologist dealing with problems in experimental psychology. This post calls for flair in apparatus design and construction. Candidates should have good background in general workshop practice. Salary scale £675-£820. Applications should be sent to the Secretary, Institute of Psychiatry, The Maudsley Hospital, Denmark Hill, S.E.5. (Ref. U.S.A.P.). W 3362

UNIVERSITY OF DURHAM. The Medical School, King's College, Newcastle upon Tyne, 1. Applications are invited for the post of Laboratory Electronics Technician in the Department of Medicine. The successful applicant will be required to take part in the maintenance of medical electronic apparatus and in the development of electronic apparatus for research. The appointment will be at a suitable point on the College salary scale for technicians (£440-£590) or senior technicians (£615-£715) according to age, qualifications and experience. Applicants who should be qualified technicians should write giving age, education, qualifications, experience and references to the Professor of Medicine, The Medical School, King's College, Newcastle upon Tyne, 1. G. R. Hanson, Registrar of King's College. W 3346

THE UNIVERSITY OF LIVERPOOL. Applications are invited for an Assistant Computer Maintenance Engineer for a Deuce computing machine installation. Previous experience of computer maintenance is not essential, but a knowledge of computer design, or of pulse techniques as supplied to radar, would be advantageous. Initial salary £650—£800 per annum, according to qualifications and experience. Further particulars may be obtained from the Registrar, to whom applications should be forwarded as soon as possible. W 3369

UNIVERSITY OF SOUTHAMTON. Instrument Mechanic or Tool Maker, preferably under 30, required for the Mechanical Workshop of the Electronics Department. Applicants should be able to do their own milling and turning and be capable of producing mechanical apparatus on a "one-off" basis. Experience of precision work is desirable but no experience of electronic techniques is required. Excellent working conditions, hours and holidays. Salary scale £420 x £20 to £570 per annum, starting salary according to age and experience. Staff superannuation scheme. Applications in writing, giving full details of experience and qualifications, together with the names of two persons to whom reference may be made should be sent to the Secretary and Registrar, as soon as possible. W 3381

WESTMINSTER HOSPITAL, London, S.W.1. Electronics Technician required in Electronics Section of the Physics Department. The work is chiefly research and development with some servicing of apparatus in routine use. The appointment will be made in the Technician or Senior Technician grade, depending upon age, qualifications and experience. Applications including names of 2 referees as soon as possible to House Governor. W 3354

SITUATIONS VACANT

AN INTERESTING VACANCY exists for a senior engineer with a broad background of experience in the field of television receiver development and design in the laboratory of a large American company in Switzerland. Maturity and an interest in working with a broad spectrum of engineers in firms throughout Europe is desirable. Box W 1166.

A PHYSICIST OR ENGINEER is required for development work on a wide range of acoustic problems including ultrasonic pulse transducers, electro-acoustic filters and ultrasonic flaw detection. The applicant must have a good academic record and a thorough background of experience in this or allied fields. He must be capable of initiating work and carrying it through without close supervision. A progressive salary will be paid and pension scheme is in operation. Please send details immediately to Glass Developments Ltd., Sudbourne Road, S.W.2. W 3334

A.B. METAL PRODUCTS LTD. require additional technical representatives for their Special Component Products Division. It is essential that applicants should have good connections in the Instrumentation and Electronics field. Write stating qualifications and experience to The Sales Manager, 17 Stratton Street, London, W.1. or telephone for interview GROsvenor 7131. W 3335

ASSOCIATED-REDIFFUSION has vacancies for Links Operators. Applicants should be experienced in the operation and maintenance of television microwave links and line transmission systems. Starting salary £840, rising to £997 upon attainment of required technical standard. Applications should be made in writing to A.G.M. (Staff), Associated-Rediffusion Ltd., Television House, Kingsway, London, W.C.2. W 3366

AUSTRALIA. ELECTRO-MEDICAL ENGINEER. We are the largest organisation in our field in the Southern Hemisphere, and are interested in hearing from engineers who are interested in emigrating to Australia. It is essential that they have experience in the fields of either selling, science and installation, or design of X-Ray, Electro-medical and allied equipment. Write in complete confidence to: The Managing Director, Watson Victor Limited, 9-13 Bligh Street, Sydney, Australia. W 1164

DAVY AND UNITED ENGINEERING COMPANY LIMITED invite applications for vacancies in their rapidly expanding Instrument Division, for Electronic Engineers for design and development of industrial controls and instruments. Applicants should have a degree in physics or electrical engineering with several years' experience on the design of electronic circuits. Successful candidates will be expected to spend a certain amount of time away from Sheffield in commissioning new equipment. Good conditions. Dining facilities. Contributory pension scheme. Apply in writing with full details of age, experience, etc. to: Personnel Department, Davy and United Engineering Co. Ltd., Darnall Works, Sheffield 9. W 3376

DESIGN ENGINEER for Control Systems and Equipment, to assist in developing a new range of controllers. Originality, a strong interest in Electronics and experience of Industrial Control work essential. Graduate preferred. Write fully to: Elcontrol Limited, Hitchin, Herts. W 3361

DEVELOPMENT ENGINEER (ELECTRONICS) Hilger & Watts Ltd, 98 St. Pancras Way, London, N.W.1., invite applications for this post. The essential qualifications are a Degree in Electrical Engineering or Physics, with experience in the field of Servo Mechanisms. The successful applicant will be required to assist in the design and development of Process Control Instruments. This post offers the opportunity of a worthwhile career in a progressive and expanding organization. Applications giving all relevant information should be addressed to the Company's Chief Personnel Manager. W 3377

ELECTRONICS RESEARCH LABORATORY STAFF. Senior qualified Electronics Engineers of Degree or Higher National Certificate standard are required for interesting work in connection with a number of projects in the field of electronics, including the application of transistors to television and similar equipment. Applicants must have suitable academic qualifications and experience in laboratory procedure. They will normally be expected to be able to handle a project from its inception to its final conclusion. Box W 340.

CLASSIFIED ADVERTISEMENTS
continued on page 192

POTTED COMPONENTS

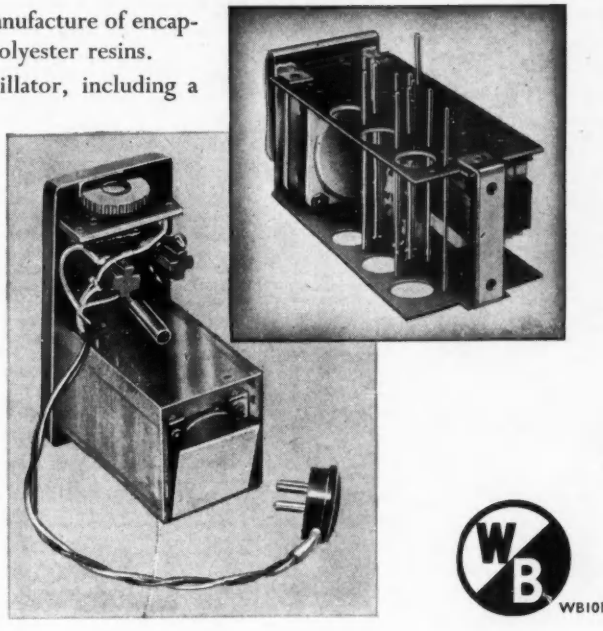
WE are specialists in the design and manufacture of encapsulated components in epoxy and polyester resins.

Illustrated here is a P.O. type Oscillator, including a ferro-ceramic cored inductance, before and after encapsulation.

We also encapsulate diode assemblies, pulse transformers etc., and supply moulded plugs, sockets and control knobs in polythene.

All these equipments are used by government departments and aircraft companies for use in conditions of high humidity.

Our technical advisory services are available to answer any queries.



WHITELEY ELECTRICAL RADIO CO. LTD.

MANSFIELD · NOTTS

Telephone: Mansfield 1762-3-4-5

We are exhibiting at the R.E.C.M.F. Exhibition Grosvenor House, Park Lane, April 6-9 Stand No. 81.

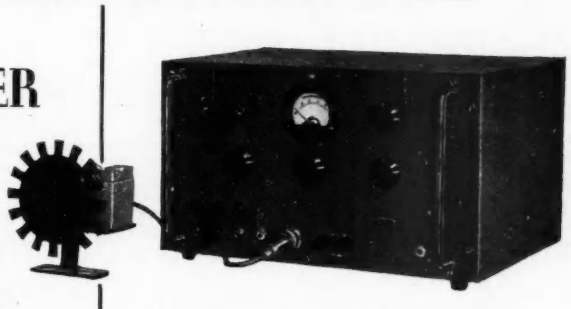
WB101

FOR PHOTO-CONDUCTIVE AND PHOTO-VOLTAIC CELLS

The MERVYN

SPECTROMETER AMPLIFIER

& CHOPPER UNIT



Especially designed for use with the photo-conductive cells now becoming available, the Mervyn SPECTROMETER AMPLIFIER is completely self-contained, needing no separate power unit.

The overall gain available is 120 dB and the phase and frequency sensitive principle of detection combined with variable band width from half to twenty cycles, deal adequately with a wide range of signal-to-noise ratios.

The chopper unit and reference signal generator are supplied with the equipment and the output is sufficient to drive a standard 3,000 ohm, 2 milliamp pen recorder.

In addition to its use with photo-conductive cells for which polarizing potentials and loads are built in, photo-voltaic types can also be employed and the circuitry is designed to allow the maximum flexibility in operation. Different input arrangements and chopping frequencies can be supplied at small extra cost.

Further information from Dept. SA/5

MERVYN INSTRUMENTS

ST. JOHN'S WOKING SURREY. Telephone: Woking 5200

P83

EE 8265 *for further details*

SITUATIONS VACANT (Cont'd.)

DEVELOPMENT ENGINEERS and Technical Assistants required for interesting work on communications, test, and industrial control equipment. Applicants should have Degree or National Certificate. Progressive, pensionable appointments. Apply Personnel Officer, Airmec Limited, High Wycombe, Bucks. W 3359

EDWARDS HIGH VACUUM LIMITED, Manor Royal, Crawley, Sussex invite applications for the following posts in their Research Laboratories. (a) Research Physicist or Mechanical Engineer. to investigate problems connected with obtaining very high vacua in large scale apparatus. Applicants should hold a degree, and have had several years' Post Graduate experience. (b) Research Physicist or Electrical Engineer, to work on the Research and Development of Instrument measuring and control systems. A degree or equivalent qualification is essential for the vacancy and electronics or electron physics experience would be an advantage. (c) Research Assistant, to assist in the investigations of melting techniques by electronic bombardment. Applicants (age 21-25) should have a pass Degree or a Higher National Certificate in Applied Physics. Some previous experience and a knowledge of electronics would be an advantage. Commencing salaries will be in accordance with age and experience. Pensions and Bonus Schemes are operated. Housing available if from London Area. Write giving full details to the Personnel Manager. W 3332

ELECTRONIC ENGINEER. Degree or H.N.C. standard. Excellent opening on development of audio equipment. Tape Recorders (Electronics) Ltd., 784, High Road, N.17. TOT 0811. W 1158

ELECTRONIC ENGINEER with electro-mechanical background required by an expanding company to apply experience in field of airborne transmission systems. Substantial four figure salary offered to a versatile man. Write details to Personnel Manager, Vactric (Control Equipment) Limited, 19-21 Brunel Road, London, W.3. W 3349

ELECTRONIC TEST ENGINEER. Due to the Company's internal promotion policy, a vacancy has arisen in Mullard Equipment Limited for a man with practical experience of a wide range of electronic equipment, particularly test instruments, and technical qualifications of at least H.N.C. standard, to design, build and maintain test gear for use in the Production Test Department. Write for application form to the Personnel Officer, 51-55 Garratt Lane, Wandsworth, S.W.18, stating most convenient time for interview and quoting reference T.E.1. W 3364

ENGINEERS with some five years practical experience of radio frequency design work required for interesting new project in Laboratory situated in South West outskirts of London. Pension Scheme. Write giving full particulars of experience and salary required to Box W 1162

ENGINEER with electronic experience up to at least O.N.C. standard, required by progressive company, for duties on type approval testing of purchased components for use in line transmission equipment. Good salary and conditions of service including Staff bonus and pension schemes after qualifying period. Apply in confidence giving full details of age, experience and present salary to Personnel Manager, Telephone Manufacturing Co. Ltd., St. Mary Cray, Kent. W 3342

PHYSICIST graduate for development of electrical insulating materials for high voltage capacitors urgently required by progressive and expanding Company of varied interests. This is a staff position with a five-day week, fortnights annual paid holiday, sports and social club, and contributory pension scheme available after qualifying period. Write giving full details of age and previous experience to the Personnel Officer, Microcell Electronics, Bridge Road, Camberley, Surrey. W 3345

ERICSSON TELEPHONES LTD. have in their Research Laboratories a number of vacancies for circuit designers and equipment engineers to work on nucleonic instruments, and interesting new developments in electronic computing and switching; both senior and junior posts are available. Applicants should have a degree or equivalent plus several years' experience of appropriate work for the senior posts; correspondingly reduced qualifications and experience will be accepted for junior posts. Salaries will be in accordance with age, qualifications and experience. Applications, giving details of age, academic or other training and qualifications, experience and starting salary required, should be sent to the Personnel Officer, Ericsson Telephones Ltd., Beeston, Nottingham. W 197

JUNIOR ELECTRONIC ENGINEER required for interesting work on the development of valve and transistor equipment applied to nuclear problems. Applicants should possess or be studying for H.N.C. C. & G.inter., or comparable qualifications, and will be required to work under project engineers on circuit design and testing prototype models. We are seeking staff who possess, in addition to technical ability, the enthusiasm and initiative to fit into an expanding team. Applications in writing to Personnel Dept., Plessey Nucleonics Ltd., Weedon Road, Northampton W 3256

MULLARD RESEARCH LABORATORIES require Technical Assistants in the Microwave Tube Division for interesting work on the design, manufacture and testing of all types of microwave tubes and their associated research problems. The work will involve mechanical design and drawing, high vacuum techniques and magnetic and microwave measurements. Applicants should have G.C.E. at Advanced Level in at least Physics and Mathematics, or H.N.C. in Electrical or Radio Engineering, and have no National Service commitments. Experience in the type of work would be an advantage, but not essential. Excellent conditions of employment are offered to successful applicants, including superannuation and life assurance. Applicants should write to the Personnel Officer, Mullard Research Laboratories, Cross Oak Lane, Salfords, near Redhill, Surrey quoting ref. DHOA. W 3375

PROGRESSIVE COMPANY situated on the South Coast announce the following vacancies for electronic engineers. Senior Circuit Designer to lead a small laboratory and be responsible for the design of electronic units used in computing systems. Senior Systems Design Engineers for interesting work on analogue computers and electronic training devices. Suitably qualified engineers apply in writing, giving full particulars, to Chief Engineer, Box W 1157.

SENIOR AND INTERMEDIATE TELEVISION ENGINEERS required with experience of studio equipment for planning studio installations. Commencing salaries (pensionable) in the range £750-£1,700. Apply: Head of Television Broadcasting Department, Central Rediffusion Services Ltd., Television House, London, W.C.2. W 3374

TECHNICIAN REQUIRED to assist mainly in development or occasional servicing of D.C. transistorized and valve amplifiers. A sound basic theoretical knowledge on amplifier design is desirable, since the candidate will be expected to progress on his own under guidance. Kindly state experience and salary required. Kensington area. Box No. W 1152.

TECHNICOLOR LIMITED. The growing use of electronics in the film processing laboratory of Technicolor Limited has resulted in the formation of the nucleus of a group whose purpose will be to design, develop and maintain a variety of industrial electronic devices. There is an opportunity within this group for a young electronic engineer. He should be of H.N.C. standard and preferably have experience of industrial electronics. He will eventually be responsible for, and should be capable of undertaking, all stages in the development of equipment from the conception of an idea to the final commissioning. Ability and enthusiasm are rated more important than experience. The Company operates a contributory Pension and Life Assurance Scheme and offers generous sickness benefits. Applicants should write giving details of age and experience to Personnel Manager, Technicolor Limited, Bath Road, West Drayton, Middlesex. W 3347

TECHNICAL OFFICER. B.E.A. require a Technical Officer (Navigational Aids) to investigate operational problems of navigational and landing systems used in aircraft; study and evaluate new radio systems and attend national and international conferences. Essential qualifications: University degree or equivalent; extensive experience in the field of navigational systems; flying experience as a crew member or Flight Observer an advantage. Salary £1,120-£1,600 p.a. Write to Senior Personnel Officer (E & S), Flight Operations Department, British European Airways, Ruislip, Middlesex. W 3355

TEST ENGINEERS required for interesting work in connection with Radar, Computers, Machine Tool Control Units, Camera Channels, Microwave Links and similar electronic equipment. Applicants must have a sound theoretical knowledge of electronics backed by practical experience in H.M. Forces or industry. Staff positions and Superannuation Scheme. Single accommodation available. Saturday morning interviews by appointment. Apply giving full details to Personnel Department, (CE 21), E.M.I. Ltd., Hayes, Middx. W 3363

THE FOLLOWING SENIOR POST is available with a rapidly expanding organization in the Dartford area. Head of Development. To be responsible for all basic and applied development in relation to the Electrical and Electronic products of the Company. A good honours degree in Physics and corporate membership of the Institute of Physics or Institution of Electrical Engineers is essential. Previous experience in a similar position, preferably covering some of the following fields, is desirable. Measurement of Light and Colour. Measurement of Ionising Radiation. Control Instrumentation. A generous salary commensurate with age and experience will be offered to suitable applicant. Terms of employment include participation in Superannuation Scheme. Applications will be treated with strict confidence and should contain brief personal details and particulars of previous training and experience and addressed to The Managing Director, Baldwin Instrument Co. Ltd., Lowfield Street, Dartford, Kent. W 3348

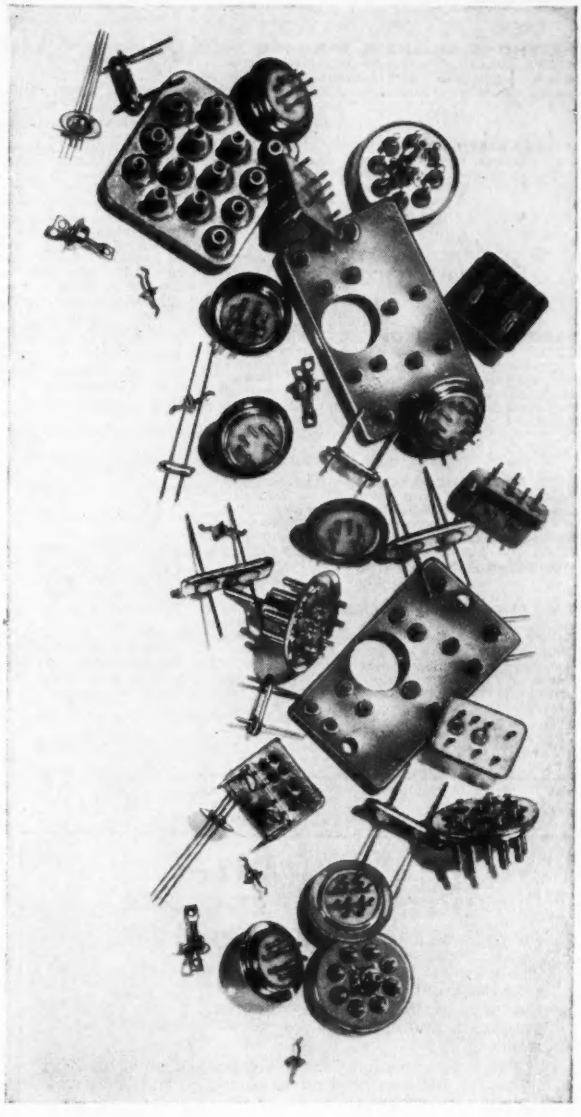
ULTRA ELECTRIC LIMITED, Radio and Television Division, require Senior Television Engineers for their Research and Development Laboratories. Applications are invited from engineers with research and development experience qualifying for work on projects such as: Wide Angle Scanning, Colour Television, Experimental Receivers—Higher Definition Systems, Combined TV./FM. Radio Receivers. The Laboratories are well equipped, modern, conveniently and pleasantly situated in a West London district, where opportunities exist for advanced technical development work. The Company operates a good Pensions/Life Assurance Scheme. All applications will be regarded as strictly confidential; should give age, qualifications; experience; salary desired; addressed in the first instance to: The Personnel Manager, Ultra Electric Ltd., Western Avenue, Acton, London, W.3. W 3379

CLASSIFIED ADVERTISEMENTS
continued on page 194

See us on Stand Nos. 53 and 144 at the R.E.C.M.F. Exhibition

More seals than ever!

We are continually extending our range of standard metal-to-glass seals as more and more equipment designers realise their advantages. You will find these Ediswan seals in such devices as: indicating instruments, gyros, vibrators, transistors, crystals, relays, transformers and vacuum systems. Increasing use is being made of them in the nuclear energy and guided weapon fields. These metal-to-glass seals have excellent electrical and mechanical properties with the added advantage of being available in a wide variety of standard designs which can be supplied promptly and fitted easily—usually by soft soldering. Our present range of seals embodies the latest techniques and will almost certainly include types suitable for your needs. If your product calls for something out of the ordinary, let us know; we are always ready to develop new seals to meet special requirements where necessary. Publication R.1843 will give you full information about our standard range; you are welcome to a copy.



Heard about our TRANSISTOR HEADERS?

Thanks to recent big advances in our metal-to-glass sealing techniques, increased production capacity and highly developed systems of quality control, we can now supply first quality transistor headers at competitive prices. We are already supplying many well-known transistor manufacturers. If you are interested in cutting your transistor manufacturing costs, ask us to quote for the type of headers you are using and send you samples.

EDISWAN

SIEMENS EDISON SWAN LIMITED
An A.E.I. Company.
155 Charing Cross Road, London W.C.2 Tel: GERrard 8660
CRC 16/8

SITUATIONS VACANT (Cont'd.)

TELEPHONE ENGINEER REQUIRED for Western Canada. Young man with experience in servicing Automatic and Intercom Equipment essential. Interview in London now. Box No. W 1160

WORKS MANAGER: To control small Electronics business in central London area. Give full particulars of previous experience and salary required. Box W 1165

EDUCATIONAL

BRADFORD INSTITUTE OF TECHNOLOGY. A full time course of 6 months for the Institution of Electrical Engineers Part III. Examination will commence in November, 1959. Further details and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford 7. Latest date of application, 1st June. W 3378

CITY AND GUILDS (Electrical, etc.) on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of modern courses in all branches of Electrical Engineering, Applied Electronics, Automation, etc., send for our 148-page handbook—FREE and post free. B.I.E.T. (Dept. 337c), 29 Wright's Lane, London, W.8. W 316

T.V. AND RADIO—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Certificate, etc., on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of Examination and Home Training Courses (including practical apparatus) in all branches of Radio, T.V. and Electronics, write for 148-page handbook—Free. B.I.E.T. (Dept. 337H), 29 Wright's Lane, London, W.8. W 187

LEARN RADIO AND ELECTRONICS the New Practical Way! Very latest system of experimenting with and building radio apparatus—"as you learn". Free Brochure from: Dept. EE 10. Radiostructor, 46, Market Place, Reading, Berks. W 3357

UNIVERSITY OF CAMBRIDGE. Department of Engineering. Postgraduate course in Control Engineering. The 1959-60 Postgraduate Course in Control Engineering will begin on 6th October 1959 and will last approximately nine months. This is the fifth course of a series which has been established in order to meet the need of Industry for men trained to a high standard in the theoretical principles and practical application of automatic control and to afford opportunity for study of advanced techniques and modern development in the general field of Control Engineering. The number of students will be limited and applications must reach the Secretary of the Department not later than 1st July 1959. Candidates should hold a degree in Engineering or a suitable alternative qualification and have had some practical training and experience. They will be required to attend for interview in Cambridge on or before 15th August 1959. Further details and forms of application for admission may be obtained from the Secretary, Cambridge University Department of Engineering, Trumpington Street, Cambridge. W 3365

FOR SALE

COMPLETE MARCONI frequency measuring consul type TMEI OA200 comprising high and low interpolating units, multivibrator, oscillator and power unit. Seen operating Bristol, low price. Box W 1161.

GUARANTEED MAGSLIPS at low prices, 3in. Resolver No. 5 (AP 10861), 50v. 50c/s. Unused, each in tin, 35s. post 2s. 1d. Large stocks of these and other types.—P. B. Crawshay, 94 Pixmore Way, Letchworth, Herts. Tel.: 1851. W 321

EHT GENERATOR by Hivolt 30 KV. 40/80 KCs. P. Joisce, 2 Hartford Road, Bedlington, Northumberland. W 1155

MAGSLIPS, SELSYNS and many other items connected with automatic and remote control mechanisms are marketed by Servo & Electronic Sales Ltd. Brochure available on request. See our display advertisement on p. 176. W 202

QUANTITY of new 12-way P.V.C. Cable Conductors 14/36. Inquiries: Taylor, Birmingham. Birchfields 4246. W 1163

SERVICE

METALWORK. All types cabinets, chassis, racks etc., to your own specifications. Philpott's Metalworks Ltd., Chapman Street, Loughborough. W 341

WELDED DIODES. We should be pleased to hear from prospective consumers of these units with a view to laying down a possible production programme. This is a completely independent company contemplating manufacture to the electronics industry. Box W 1153.

CAPACITY AVAILABLE

TRANSFORMER and coil windings, capacity available. Windings carried out to customers' specification. Large or small orders undertaken. Enquiries to: W.L.R.S., 30 Fauconberg Road. Chiswick, W.4. Chi. 0384. W 1159

ASSISTANT INSTRUMENT ENGINEER

for CHAPELCROSS NUCLEAR POWER STATION

to work in the Instrument Department, which is responsible for installation, servicing and testing of all Works instrumentation including nuclear, electronic, physical, electrical, pneumatic, health, physics and industrial television equipment.

This is an opportunity for an engineer to gain experience of reactor and associated power plant instrumentation and control. He will be responsible to the Instrument Engineer for liaison with the Reactor Operations and Technical Department during reactor start-up tests and for subsequent instrumentation tests and experiments, organisation and co-ordination of a planned maintenance system, investigation of operational and servicing problems on instrumentation and other duties which may include responsibility for the acceptance of instrument installations from the Consultant Engineers and installation and calibration tests.

A recognised engineering apprenticeship or comparable training and corporate membership of a senior engineering institution, or equivalent are essential. Industrial instrumentation experience is required, together with the ability to lead and co-ordinate the activities of technicians and mechanics. Physics, radar or light electrical background may be an advantage. Where necessary, training in nuclear aspects of the work will be given.

SALARY BETWEEN £845 (at age 25) and £1,315

Contributory Superannuation. Staff housing scheme.

Send postcard for application form, quoting Reference 2977/J.43 to Works Secretary.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY INDUSTRIAL GROUP, Chapelcross Works, Annan, Dumfriesshire, Scotland.

CLOSING DATE: 4th MAY, 1959.

DECCA RADAR RESEARCH LABORATORIES

TRANSISTOR ENGINEERS

Engineers experienced in transistor circuit design are required to join an enthusiastic group whose activities are expanding on a wide front in the fields of:

DATA PROCESSING
NAVIGATIONAL AIDS
RADAR
LOGICAL DESIGN OF SYSTEMS
AIRBORNE COMPUTERS

Engineers with experience in other fields and who wish to widen their interests are also invited to apply.

Our aim is to exploit the most advanced techniques in new applications in these interesting fields, and to produce equipment to top-rate engineering standards. Every encouragement is given to personal initiative and original thought. For the right men there are opportunities of increasing responsibility, and personal merit and contribution to progress are suitably rewarded.

Write quoting RLA/215 to: DECCA RADAR LTD., Lyon Road, Walton-on-Thames, Surrey.

SOLARTRON I SVERIGE

Solartron Electronic-gruppen hör till de ledande tillverkarna av elektronisk utrustning i Europa. Solartron kan nu även i Sverige erbjuda teknisk hjälp och expertrdågivning i alla sammanhang där tillämpning av elektronik är aktuell.

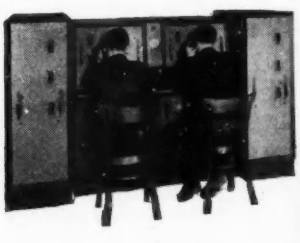
Solartrons elektroniska precisionsinstrument användes över hela världen och med ständigt vidgande användningsområden. Absoluta, relativa och vektorvärden; visuell analys och indikering (med oscilloskop); snabbuträkning av servoelement och dynamiska system; undersökning och kontroll av kommunikationsnät — dessa och en mängd andra uppgifter inom både forskning och industri utföres varje dag med hjälp av Solartrons precisionsinstrument.

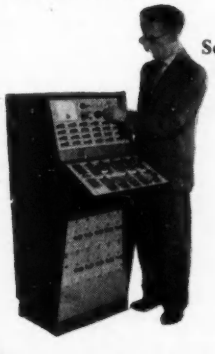
Ett nytillskott i Solartron-familjen är analogimaskinerna SPACE. Andra utrustningar av stor betydelse är t. ex. ERA — Solartrons Elektroniska Avläsningsautomat; Solartrons Radar-Simulatorsystem; SAKI — för undervisning av hålkortsoperatörer — samt kontrollutrustningar för industrin såsom den Automatiska Fluorescerande Röntgenspektrometern och den snabba Elektroniska kontrollvågen. Dessutom kan stabiliserade kraftanläggningar av alla typer för såväl konventionell som transistoriserad kretsutveckling levereras.

Det goda rykte som hela kedjan av Solartron — produkter åtnjuter för sin funktionsstabilitet, sin exakthet vid mätningar och indikeringar — med garanterad tillförlitlighet även under de svåraste arbetsförhållanden — har vunnits genom användan — de av standardiserade precisionmått vid tillverkningen både för mekanik och elektroteknik. Ett bra kvalitetsbevis är, att många Solartron instrument erhållit den brittiska Försvarsstabens godkännande för användning i fält.

Solartron Radar—Simulator system—

Typenheter av ett flermåls simulatorsystem användes nu i Atlantpaktsländerna. Systemet kan appliceras på alla typer av radarutrustning.



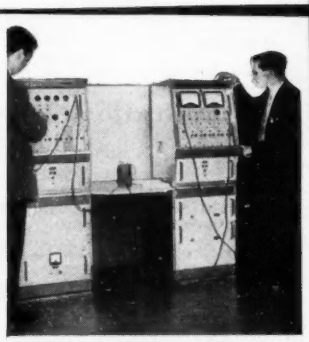


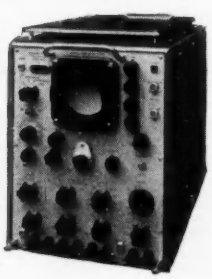
Solartron MINISPACE Analogimaskin TY 864—

för snabblösning av komplexa dynamikproblem — data-omvandling, simulation av kontrollsystem etc.

Solartron PRA, som ger direkt indikering på

resistiva och reaktiva komponenter i en uppspaltad testsignal, är en utomordentlig hjälp för instrumentering av lågfrekvenssystem med mycket låga frekvenser samt för manöverorgan vid atomreaktorer, ävensom för värmeväxlare och tung kemikalieframställning.





Oscilloskop med Dubbelstråle CD 711S.2 (CT 414)

Ett precisionsbyggt instrument från likström (noll c/s) till 7 Mc/s bandbredd på bägge ingångarna ('7'), testad under svåra vibrations — och klimatförhållanden för att passa alla användnings-områden inom industrin.

Tag redan nu kontakt med Solartron som ger Er expertisens råd och upplysningar om den senaste utvecklingen inom elektroniken.

SOLARTRON AB
Hedinsgatan 9
STOCKHOLM Ö

THE SOLARTRON ELECTRONIC GROUP LTD
THAMES DITTON · SURREY · ENGLAND
Telefon: EMBerbrook 5522 Internationell Telex: 23842 Solartron T. Dit.
Telegramadress: Solartron Thames Ditton.

TELECOMMUNICATIONS ENGINEERS

The **TELECOMMUNICATIONS DIVISION** of **ELLIOTT BROTHERS (LONDON) LIMITED** has openings for good **TELECOMMUNICATIONS ENGINEERS** who have the initiative and ability to take advantage of the unique opportunities which exist within this rapidly expanding organization.

Vacancies are in the following categories:—

Ref: 01 Systems Planning Engineers
02 Microwave Engineers
03 U.H.F. Engineers
04 V.H.F. Engineers
05 I.F. Engineers
06 Transistor Engineers
07 Electronics Design Engineers

Ref: 12 Microwave Technical Assistants
13 U.H.F. Technical Assistants
14 V.H.F. Technical Assistants
15 I.F. Technical Assistants
16 Transistor Technical Assistants
17 Draughtsmen

Academic qualifications are important but not essential for every post. Practical experience and a personal desire for advancement by merit are of paramount importance.

Attractive salaries commensurate with ability and type of appointment will be paid to successful applicants.

All Engineers wishing to pursue the matter should apply immediately in writing stating in brief, age, present employment, qualifications, previous experience and indicating field of interest.

Correspondence will be treated in the strictest confidence and should be addressed to:—

The Personnel Manager,
Elliott Brothers (London) Limited,
Elstree Way · Borehamwood · Herts.

SOLARTRON
ELECTRONIC & MECHANICAL ENGINEERS
INDUSTRIAL CONTROLS

Solartron Industrial Controls Ltd., has already become established in plant measurement and control of physical and chemical parameters with automatic high speed check weighers, automatic X-ray spectrographs and electronically programmed hydraulic servos.

The programme ahead offers opportunities to:

MECHANICAL DEVELOPMENT ENGINEERS
with experience in the design and development of light electromechanical devices to join teams working on the above projects.

SENIOR ELECTRONIC TEST ENGINEER
to set up procedures, rigs and systems to ensure suitable testing of existing and future products. The opportunity should arise later to lead a team of test engineers.

ELECTRONIC DEVELOPMENT ENGINEER
to work with a team developing through to production automatic X-ray spectrometers.

SENIOR MECHANICAL DESIGN DRAUGHTSMAN
with experience in the design of precision mechanisms and instruments and interest in the introduction of new constructional techniques.

These appointments will be located at FARNBOROUGH, Hants.

The Solartron Group of Companies continues to expand rapidly and offers above average prospects.

WHY NOT DISCUSS YOUR FUTURE CAREER WITH US?

SOLARTRON

Apply to:—
The Group Personnel Officer,
The Solartron Electronic Group Ltd.
Farnborough, Hants

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH & DEVELOPMENT DEPARTMENT

INSTRUMENT ENGINEERS required in the Electronics and Instrument Section of the Research Laboratories, Leatherhead, Surrey. The Section provides an instrument service for all departments of the Laboratories, and duties include the maintenance, calibration and repair of a wide variety of physical, chemical and electrical instruments. Candidates should have a Higher National Certificate or equivalent qualification.

Experience in electronic or nucleonic equipment will be an advantage. Salary on a scale within the range £570-£1,300 p.a., according to duties and responsibilities.

Application forms obtainable from the Personnel Officer, 24-30 Holborn, London, E.C.1, should be completed and returned as soon as possible. Please mark envelopes "Confidential Ref. EE /56".

THE ENGLISH ELECTRIC COMPANY LTD.,
STEVENAGE, HERTS.

require a

SENIOR PRODUCTION ENGINEER (ELECTRONICS)

to fill a Senior position on the production of Electronic Units for Guided Weapons. Mechanical Engineers with extensive experience of medium batch production of electronic units, or Electronic Engineers with a strong, practical production outlook, will suit this position. Knowledge of printed circuitry, potting, encapsulation and later electronic practices such as flow and plate soldering, is required. This is a position with responsibility calling for drive and initiative. There is great scope for advancement and a substantial salary will be paid to the selected applicant.

Housing assistance may be made available in certain cases after an initial waiting period.

Replies should be made in the first instance to Dept. C.P.S., Marconi House, 336/7 Strand, London, W.C.2, quoting reference EE 1394R.

HUNTING ENGINEERING LIMITED
require
TOP GRADE ELECTRONIC DRAUGHTSMEN
for work on M.O.S. contracts and commercial projects in the field of automation.
Vancancies exist for both design and detail draughtsmen who are experienced in the design of high-reliability electronic equipment for use under arduous conditions.
The senior posts require men with initiative capable of working with the minimum of supervision in an engineering design team.
Draughtsmen concerned with detailing must be capable of breaking down a projected scheme to working drawings suitable for small-scale production.
Contributory Staff Pension and Life Assurance Scheme.
Applications, giving full details of qualifications, experience, age and salary desired, and quoting ref. H.E.L./71/E should be forwarded to:
THE PERSONNEL MANAGER,
HUNTING ENGINEERING LIMITED,
THE AIRPORT,
LUTON, BEDS.

Application, Development and Processing Engineers

OPENINGS IN UNITED STATES WITH IMPORTANT ELECTRONIC COMPANY FOR APPLICATION, DEVELOPMENT AND PROCESSING ENGINEERS TO DO TECHNICAL WORK ON ELECTRONIC VALVES.

APPLICATION ENGINEERS required for work on receiving valves. Should have Degree in Electrical Engineering or Physics (or equivalent), and four years' experience in radio and television circuitry.

DEVELOPMENT AND PROCESSING ENGINEERS are required to have Degree in Electrical or Mechanical Engineering (or equivalent) and three years' experience on development or processing work (or both) on electronic valves.

Excellent opportunities, salaries commensurate with experience, expenses paid. Candidates are requested to send applications to BOX W 3333, giving educational background, experience and personal information.

Advance

requires

ELECTRONIC PROJECT ENGINEERS

Capable of developing electronic test and measuring instruments from conception to design for quantity production. Such engineers should have a degree or equivalent and good experience in this field.

CONSTANT VOLTAGE TRANSFORMER ENGINEER

An Engineer with experience in the design of transformers and iron cored components to work on our range of saturated constant voltage transformers.

These appointments for men of ability will be in the design department of our modern factory at Hainault.

Apply to:

The Technical Director

ADVANCE COMPONENTS LTD.

ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX

Scientists and Engineers are required for teams engaged in Research in the following fields

DATA TRANSMISSION
DATA HANDLING
DIGITAL COMPUTER TECHNIQUES

These vacancies are due to the expansion of the programme at the Electronics Research Laboratory, Roke Manor, Romsey.

The Establishment is situated in attractive surroundings and is organised to encourage initiative and originality.

A degree in Physics or Electrical Engineering is required and experience in pulse or digital circuits using transistors or magnetic cores would be an advantage. The posts are permanent and pensionable with commencing salaries in the range of £1,000-£1,400 depending on qualifications.

Applications should be made to

Dr. DENIS TAYLOR,
Electronics Group,
The Plessey Company Limited,
Vicarage Lane, Ilford, Essex.

THE BRITISH BROADCASTING CORPORATION

Opportunities for Engineers

Vacancies exist in the Transmitter Department, for Engineers who are citizens of the United Kingdom and are between 20 and 30 years of age.

The minimum qualifications include two years' practical experience, other than operational, in electronics, radio or telecommunications gained either in H.M. Forces or in Industry, the Higher National Certificate in Electrical Engineering or the City and Guilds of London Institute Final Certificate in Telecommunications Engineering or an equivalent academic qualification.

Successful applicants are normally appointed to high-power, short-wave transmitting stations for initial training prior to a 14 weeks' course at the Engineering Training School, a fully residential establishment at Evesham, Worcs. After training, engineers will be posted to a transmitting station within the United Kingdom although preference for a particular area will always be considered.

The starting salary for these posts is £705 p.a. and rises by annual increments to £1160 p.a. There are good opportunities for promotion to more highly graded posts.

Further particulars and application form may be obtained from

Engineering Recruitment Officer,

Broadcasting House, London, W.1.

quoting reference; EX.203. E.E.

YOUR FUTURE IN ELECTRONICS

TRANSISTORS—FERRITES—MAGNETICS
PRINTED CIRCUITS—POTTED CIRCUITS

and their application to all branches of

RADIO COMMUNICATIONS & ELECTRONIC INSTRUMENTATION

If you are interested in any of the above subjects and are anything from a Technician to a Senior Engineer/Physicist, staff vacancies are currently available in the salary scale

£500 to £2,500 p.a.

depending on qualifications and experience.

An excellent staff contributory superannuation scheme is in operation and New Town Housing can be made available to successful candidates. Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience to date, to the Technical Director,

RACAL Engineering Limited

WESTERN ROAD · BRACKNELL · BERKSHIRE

THE METAL BOX COMPANY LIMITED

Production Department, (Alperton, West London)

requires an

ELECTRONICS ENGINEER

Applicants should be of University Degree or City and Guilds Final or Higher National Certificate standard. Experience in the field of industrial electronics is desirable but initiative and ability for original thinking are the primary requirements. Salary related to qualifications and experience.

Write:

Staff Division
THE METAL BOX COMPANY LTD.
37 BAKER STREET, LONDON, W.1

quoting Ref. PRE/7

ELLIOTT BROTHERS (LONDON) LIMITED

VALVE DIVISION

VALVE ENGINEERS and TECHNICAL ASSISTANTS are required for interesting work on the development and manufacture of microwave gas-filled and transmitting valves. Both types of appointment demand some experience of vacuum tube design and manufacture and the Engineers will possess a degree or equivalent in Physics or Engineering.

The rapid expansion of this Division should result in good prospects for the successful applicants.

Please write to the Personnel Manager (Ref. 037), Elliott Brothers (London) Limited, Elstree Way, Borehamwood, Herts.

COSSOR INSTRUMENTS LIMITED

require

SENIOR ENGINEERS

for EXPANDING DEVELOPMENT DIVISION

Preference given to men with degree or equivalent academic qualifications plus several years design experience, although proven design ability and wide experience will be considered in lieu.

These are PROGRESSIVE POSTS in a young and expanding Company within an established group. Salary in accordance with qualifications and experience but based on a generous scale. Apply in confidence (Marked Personal) to:—

The Technical Director,
COSSOR INSTRUMENTS LTD.,
Highbury Grove · London · N.5.

PHYSICISTS AND ELECTRICAL ENGINEERS

are urgently required in the

RADAR RESEARCH LABORATORY

of

ELLIOTT BROTHERS (LONDON) LIMITED.

There are vacancies for men and women with experience and also for new graduates in a modern laboratory providing advanced techniques for the Radar, Telecommunications, Electronic Valve, Radar and Microwave & Electronic Instrument Divisions of the Company.

Research and development is required in all fields appropriate to the work of these Divisions.

Some of the problems being studied are:—the characteristics and applications of new materials; new forms of propagation and wave-guide transmission of microwave energy; wave-guide circuits, components and instruments; microwave aerials; investigation and design of transistor circuits.

Please apply to:
The Personnel Manager (Ref. 070)
Elstree Way,
Borehamwood, Herts.

ENGLISH ELECTRIC

MECHANICAL ENGINEERING LABORATORIES
WHETSTONE NEAR LEICESTER

wish to appoint a number of

DEUCE COMPUTER SITE ENGINEERS

Applications are invited from Electronic Engineers to join the team responsible for the operation and servicing of the DEUCE Digital Computer installation.

Applicants should be thoroughly experiencedi n industrial electronics and an adequate theoretical background is essential. Some knowledge of pulse techniques would be an advantage.

Successful candidates will be given a comprehensive training in DEUCE servicing at the Company's Computer Division and on taking up their duties some shift work may be involved.

Please write, giving details of qualifications and experience, to Dept. C.P.S., Marconi House, 336/7 Strand, W.C.2, quoting reference EE 1990A.

MARSHALL AIRPORT WORKS · CAMBRIDGE

ELECTRONIC ENGINEER

Required for servicing specialised equipment involving basic knowledge of pulse and digital computor techniques.

Special training given.

Good salary and conditions.

Written applications in first instance giving full particulars, age, experience, etc., to:-

PERSONNEL MANAGER

ULTRA ELECTRIC LTD.

ACTON, LONDON, W.3.

Invite applications for the following positions in their modern, well-equipped Laboratories of the Special Products Division.

(1) SENIOR ELECTRONIC DEVELOPMENT ENGINEERS
for work on:
- (*a*) **MICROWAVE TRANSMISSION DEVELOPMENT.**
- (*b*) **SPECIAL RADIO COMMUNICATION DEVICES.**
- (*c*) **DATA PROCESSING EQUIPMENT.**

Applicants should have qualifications up to degree standard, have good basic experience and be capable of leading a team in the development of devices from the performance requirement stage.

(2) JUNIOR ENGINEERS
for work on:
- (*a*) **MICROWAVE AND RADIO APPLICATIONS**
- (*b*) **SIMULATOR DEVELOPMENT.**
- (*c*) **TRANSISTOR APPLICATIONS.**

Applicants should have qualifications up to degree or H.N.C. standard and preferably previous experience appropriate to the requirements of the positions stated.

These appointments offer scope for original research and development work and for personal advancement.

Good salaries, adjudged and commensurate with qualifications, will be offered to suitable applicants.

A Contributory Pensions and FREE Life Assurance Scheme is operated by the Company.

All applications will be regarded as strictly confidential and should give full details of present and past positions held, age and qualifications. In the first inst ance, please write to:

The Personnel Manager,
ULTRA ELECTRIC LTD.,
Western Avenue, Acton, London, W.3.

HUNTING ENGINEERING LIMITED

require

ELECTRONIC ENGINEERS

for work on M.O.S. contracts and commercial projects in the field of automation.

Vacancies exist for senior and junior engineers who are preferably experienced in the design of high-reliability equipment using both vacuum and semi-conductor devices.

All posts require initiative and the capacity to work with minimum supervision in design teams.

The senior grades will be responsible for the design from specification to small quantity production of high grade equipment.

QUALIFICATIONS
A degree in physics or electrical engineering or H.N.C. in electrical engineering or electronics is preferred but not essential. Membership of a professional institution is an advantage.

Excellent further prospects exist for progressive individuals in a continuously expanding organisation.

Contributory Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary desired, and quoting ref. H.E.L./70/E should be forwarded to:

THE PERSONNEL MANAGER,
HUNTING ENGINEERING LIMITED
THE AIRPORT,
LUTON, BEDS.

DECCA RADAR LIMITED

Senior Electronic Engineers

Assistant Engineers

The Display and Data Handling Laboratory which is studying the extensions of automatic data processing methods to Air Defence and Civil Aviation problems requires Senior Electronic Engineers and Assistant Engineers for their Techniques and Electronic Design Sections to work on:

(a) **Analogue Transistor Circuits**

(b) **Digital Transistor Circuits**

(c) **Design of data handling systems**

Senior applicants should have a wide experience in the use of D.C. amplifier and pulse circuits. Ability to work on own initiative and to direct the work of others essential.

Assistant Engineers should have at least two years' experience of pulse circuits.

Apply: Personnel Officer,

2 Tolworth Rise, Surbiton, Surrey

BRITISH TELECOMMUNICATIONS RESEARCH LTD.

TAPLOW, BUCKS

Applications are invited from qualified and experienced ENGINEERS for the following vacancies:

LINE TRANSMISSION SYSTEMS
- (*a*) Development of TRANSISTOR circuits.
- (*b*) Development of small TRANSFORMERS and INDUCTORS.
- (*c*) Investigation and assessment of COMPONENT LIFE.
- (*d*) Development and design of FILTERS and NETWORKS.

RADIO SYSTEMS
- (*e*) Development of MINIATURE VHF Equipment (2 vacancies).

TELEGRAPH SYSTEMS
- (*f*) Development of TELEGRAPH Equipment. Knowledge of transistor circuits required. Services' experience an advantage.

DRAUGHTSMEN are also invited to apply for two vacancies for work on the design of ELECTRONIC Equipment.

A LABORATORY ASSISTANT, male or female, is required for a small chemical laboratory, preferably with G.C.E. A level in Chemistry, and with laboratory experience.

Two ELECTRICAL TESTERS are required for inspection of PROTOTYPE Telecommunication equipment, preferably with knowledge of bridge work and filter testing.

Salaries are assessed on the basis of age, experience and education. There is a sound Pension Scheme. Assistance with housing is offered in approved cases.

The Company's laboratories are situated in the Taplow Court Estate, a very attractive location on high land overlooking the Thames near Maidenhead, giving ideal working conditions.

An active Staff Club provides social, sporting and cultural out-of-hours' activities for which excellent facilities are available for staff and their families.

Please apply to the General Manager, quoting Ref. 1/59.

THE BANK OF ENGLAND PRINTING WORKS

require an

ELECTRONIC ENGINEER

below age 35 to join a Development Team engaged on the mechanisation of processes associated with the large scale handling of documents.

Previous experience of counting, switching or digital computing techniques is desirable.

The work will involve the preparation of original schemes and the development of prototype equipment into reliable working systems.

Pensionable appointment. Starting salary up to £1,200. Write stating age, education, qualifications and experience to:

The Staff Manager,

BANK OF ENGLAND PRINTING WORKS
LANGSTON ROAD · LOUGHTON · ESSEX

ELECTRONIC RESEARCH

Scientists are required to lead small teams carrying out original research in electronics. These deal with a wide variety of interesting problems which arise in nuclear physics and which cannot be solved by presently available techniques and equipment.

A 1st or 2nd class Honours Degree required, preferably in Physics or Electrical Engineering, and independent research experience in suitable aspects of electronics. These include ultra-fast time measurements, general electronic circuit design, transistor circuit design, information handling techniques and the design of special electronic tubes.

SALARY:— PRINCIPAL SCIENTIFIC OFFICER £1510-£2155
SENIOR SCIENTIFIC OFFICER £1260-£1475

Contributory Superannuation Scheme. A house or alternatively substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer, A.W.R.E. Aldermaston: quoting ref. C.1647/42.

SENIOR AND JUNIOR ENGINEERS

Vacancies exist in the Technical Department for Engineers capable of undertaking research, development, or project control in the fields of electrical energy metering, instrumentation, electronics, or light mechanism applications. There is a considerable scope for initiative in all fields, and generous salaries will be paid to applicants of experience, enterprise and imagination.

Apply to:

The Technical Manager,
ARON ELECTRICITY METER, LTD.,
72-82 Salusbury Road,
London, N.W.6.

MICROWAVE ENGINEERS

Senior and Junior Microwave Engineers, with a minimum qualification of H.N.C. (Electrical), are required for the Development Laboratory which is engaged on magnetron applications, TR cells, ferrites, travelling wave tubes, and other allied subjects.

Apply to

Personnel Officer,
DECCA RADAR LTD.,
Development Laboratory,
9 Davis Road, Chessington, Surrey.

ARE YOU WORKING IN OUR DIRECTION...?

If you are a young qualified engineer (mid-twenties) or have several years' experience on miniature electro-mechanical devices and you are looking for space to grow—then we can offer you the opportunity you need. In an expanding division of our Research Laboratories, which is to be housed in a modern building now nearing completion, there is a place earmarked for you. An attractive salary with excellent prospects clearly make this the opportunity you have been waiting for.

Other considerations include:

Every facility for sports and social activities.
A first-class new canteen.
Generous Pension Scheme (contributory).

Write now quoting EM/E1 giving details of background and experience to:
THE PERSONNEL MANAGER

ERICSSON TELEPHONES LTD.
BEESTON · NOTTINGHAM · ENGLAND

E111—89

OXFORD UNIVERSITY

ELECTRONIC ENGINEER

The Research Laboratory for Archaeology and the History of Art
wish to recruit two members of a team who will work a Vacuum X-ray Fluorescent and Micro-probe Analysis, using transistor techniques:

(*a*) **DESIGNER ENGINEER.** Degree or H.N.C. standard with at least four years' experience. Ability to design own transistor circuits essential. Salary, £900-£1,100.

(*b*) **JUNIOR ENGINEER.** Age 22-35. At least two years' practical experience. Excellent opportunity for enthusiastic man who wishes to learn new techniques. Salary, £500-£750.

Apply, giving details of experience, to
Dr. E. T. Hall,
6 Keble Road, Oxford.

RADIO ENGINEER

required by

PYE LIMITED OF CAMBRIDGE

for an interesting post in transistor design and development.

Applicants should have several years' experience in receiver design, together with some knowledge of printed circuit techniques.

A recognised qualification (Degree, H.N.C. or equivalent) would be an advantage. Starting salary would be commensurate with qualifications and previous experience, and housing assistance may be given in certain cases.

Please address applications to the Chief Engineer, quoting "RE".

MICROWAVE ENGINEERS

PYE TELECOMMUNICATIONS LTD.

have a number of vacancies for development engineers with experience in the design of microwave radio relay systems for the transmission of television and multichannel applications.

Letters quoting age, experience, salary required, etc., should be addressed to:-

THE PERSONNEL MANAGER

PYE TELECOMMUNICATIONS LTD.

DITTON WORKS, NEWMARKET ROAD, CAMBRIDGE

COMMUNICATIONS

MARCONI'S have attractive overseas appointments in connection with the maintenance of modern communications systems. If you have experience of telephone carrier systems or multichannel radio links there may be a post for you.

The posts carry generous paid leave and furnished family accommodation. A good number of the appointments will lead to permanent pensionable employment; others are on contract terms.

Please write, giving full details and quoting reference EE 2047J, to Mr. J. L. Scott, Dept. C.P.S.,

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED

Marconi House, 336/7 Strand, London, W.C.2

ELECTRO MECHANICAL ENGINEERING

A.I.D. A.R.B.

Assistant required to Director of small company, 25-30 employees, North London, sub-contracting for national companies, manufacturing radar/radio, electro mechanical units, etc., precision sheet-metal work and machining.

Applicants, 30-35, with practical engineering background, good organiser, estimator, some purchasing experience in London area.

This is an opportunity for competent go-ahead man of good education, who could assume the major responsibility for the firm's progress and expansion, who wants high income quickly.

Salary £1,000 (minimum). Good bonus on results. Pension Scheme.

Write fully, in confidence, Box W 3344.

ELLIOTT BROTHERS (LONDON) LIMITED

SENIOR

ELECTRONIC ENGINEERS

A team engaged in the development of advanced autopilot systems for the civil aircraft industry, requires the services of experienced transistor circuit designers. Servo mechanisms experience would be advantageous.

These appointments offer excellent opportunities for advancement in the rapidly expanding field of control engineering.

Applications in writing, stating age, experience and salary required, should be made to:—

Personnel Manager (Ref: 076)

ELLIOTT BROTHERS (LONDON) LIMITED

ELSTREE WAY · BOREHAMWOOD · HERTS.

EE 8261 *for further details*

micro-electric

Precision miniature components for electronic equipment

Cristal Microphones
Miniature Volume Controls and Switches
Small Transformers and Toroidal Transformers
Plug Sockets for miniature tubes and transistors

Write for catalogue and information

MICRO-ELECTRIC LTD. — Zurich 52 — Switzerland

Trade Mark established 1895

SPECIALIST MANUFACTURERS OF HIGHEST GRADE

INSTRUMENT WIRES.

COPPER AND RESISTANCE WIRES.

"MANGINSAX" — GENUINE MANGANIN ENAMEL, SILK, RAYON COVERED.

P.V.C. POLYTHENE, P.V.C. MICROPHONE "INSUGLASS", THERMOCOUPLE, etc.

THE SAXONIA ELECTRICAL WIRE CO. LTD.

Contractors to the Admiralty War Office Air Ministry

ROAN WORKS, GREENWICH S.E.10

Grams: "SAXONIST LONDON" Phones: GREenwich 3713/4

"GREENWICH CABLES & FLEXIBLES"

EE 8268 *for further details*

The Engineer

BUYERS GUIDE

1959

CONTENTS

Associations, Institutions and Societies connected with the Engineering Industry — Address Section — National Undertakings. Trade Names — **Buyers Guide** — U.K. Agents for Foreign Firms. Forthcoming Engineering and Industrial Exhibitions. **Subscribers to 'The Engineer' are sent one free copy.** Additional copies now obtainable at 7/6 each (postage 1/9) from

The Manager—

The Engineer

28 ESSEX STREET, STRAND, LONDON, W.C.2.

Phone: CENtral 6565

EE 8276 *for further details*

EE 8269 *for further details*

Mike Ron and Milly Torr

We work in a very rarified atmosphere at Edwards. You never know what our research people will do next. They have lived with and worked with microns and millitorrs for so long that now they are even seeing them. And it is not such a bad thing, as it turns out. Mike Ron is, as you can tell from his picture, quite a likeable chap, just bursting with brains and experience — measuring up to vacuum requirements on an international scale. As for Milly Torr, she not only has the backing of the British Standards Institution, but shares with Edwards the closest possible European connections.

They have a magic benevolent touch these two; they make things possible that, without them, just could not be. Medicine, physics, chemistry, nuclear science, metallurgy, foodstuffs and electronics, all these and more too owe something to Mike and Milly—and Edwards.

Mike and Milly don't go in much for high pressure talk, but when it comes to low pressure techniques—well, keep watching these pages.

. . . in the flesh!

"SPEEDIVAC"

EDWARDS HIGH VACUUM LTD., MANOR ROYAL, CRAWLEY, SUSSEX, ENGLAND. ***Crawley 1500***

MR1

INDEX TO ADVERTISERS

A

A.K. Fans, Ltd. 168
A.P.T. Electronic Industries, Ltd. 45
Acru Electric Tool Mfg. Co., Ltd. 170
Adcola Products, Ltd. 184
Advance Components, Ltd. .. 31, 71, 138, 197
Air Control Installations, Ltd. 147
Airmec, Ltd. 11
Allied Distributing Corpn., Ltd. 186
Allied Electronics, Ltd. 178
Alloy Wire Co., Ltd. 148
Alma Components, Ltd. 3
Anglo-American Vulcanized Fibre Co., Ltd. .. 140
Ardente Acoustic Laboratories, Ltd. 3
Armstrong Patents Co., Ltd. 77
Armstrong Whitworth Aircraft, Sir W. G., Ltd. 66
Aron Electricity Meter, Ltd. 200
Asmidar Plastic Moulding Machines, Ltd. .. 159
Atlas Plating Works, Ltd. 178
Atomic Energy, Electronics, Automation & Television Films, International Congress, Rome 158
Automat Co., Ltd. 183
Automatic Telephone & Electric Co. Ltd. .. 118
Autophone, Ltd. 186
Aveley Electric, Ltd. 173

B

B. & K. Laboratories, Ltd. Inset facing pp. 40 & 41, 7, 40, 41
B.I.P. Chemicals, Ltd. 84
Bank of England Printing Works 200
Barr & Stroud, Ltd. 163
Belclere Co. 154
Belling & Lee, Ltd. 69, 158
Berry's Radio 184
Birch, H. A., & Co., Ltd. 185
Birlec, Ltd. 203
Bird, Sidney S., & Sons, Ltd. 44
Blackburn & General Aircraft, Ltd. 22
Boulton-Paul Aircraft, Ltd. 175
Bolton, Thomas, & Sons, Ltd. 167
Brandenburg, Ltd. 100, 101
Braybead (Ascot), Ltd. 135
Bribond, Ltd. 82
British Broadcasting Corporation 197
British Electric Resistance Co., Ltd. 97
British Ferrograph Recorder Co., Ltd. .. 126
British Insulated Callender's Cables, Ltd. Cover ii
British Nylon Spinners, Ltd. 74
British Paints, Ltd. 68
British Plastics Developments, Ltd. 176
British Telecommunications Research, Ltd. .. 199
British Thomson-Houston Co., Ltd. 29
Broom & Wade, Ltd. 102
Brown, N. C., Ltd. 176
Broxlea Products, Ltd. 204
Brush Crystal Co., Ltd. 152, 177
Bullers, Ltd. 70
Burgess Products Co., Ltd. 65

C

C.C.L., Ltd. 148
Cambridge Instrument Co., Ltd. 175
Cannon Electric (Gt. Britain), Ltd. .. Cover iv
Carr Fastener, Ltd. 88
Central Electricity Generating Board 196
Chapman & Hall, Ltd. 235
Chase Products (Engineering), Ltd. 188
Ciba (A.R.L.), Ltd. 37
Cinetra Mfg. Co., Ltd. 164
Clarke, H., & Co. (Manchester), Ltd. .. 143
Colvern, Ltd. 134
Connollys (Blackley), Ltd. 80
Cossor Instruments, Ltd. 34, 35, 198
Counting Instruments, Ltd. 17
Coventry Controls, Ltd. 164
Crawshay, P. B. 170
Crofts (Engineers), Ltd. 124
Croydon Precision Instrument Co. 167

D

Dale Electronics, Ltd. 166
Davis, Jack (Relays), Ltd. 188
Daystrom, Ltd. 98
Decca Radar, Ltd. 199, 200, 194
Delapena & Son, Ltd. 136
Dobbie McInnes, Ltd. 162
Donovan Electrical Co., Ltd. 130
Dowding & Doll, Ltd. 67
Drayton Regulator & Instrument Co., Ltd. .. 141
Dubilier Condenser Co. (1925), Ltd. 32

E

E.M.I. Electronics, Ltd. 59
E.M.I. Sales & Service, Ltd. 28, 96, 111
Edwards High Vacuum, Ltd. 202
Electrical Instrument Co. (Hillington), Ltd. .. 182
Electro Methods, Ltd. 99
Electronic Components 156
Electronic Tubes, Ltd. 52
Electrothermal Engineering, Ltd. 58
Elliott Bros. (London), Ltd. .. 196, 198, 201
Engelhard Industries, Ltd. 165
Engineer Buyers Guide 201
English Electric Co., Ltd. 119, 196, 198
English Electric Valve Co., Ltd. 113
English Glass Co., Ltd. 176
Ericsson Telephones, Ltd. .. 30, 48, 129, 200
Erie Resistor, Ltd. .. .. .. Cover iii
Erskine Laboratories, Ltd. 86
Evans, Fredk. W., Ltd. 170
Expanded Metal Co., Ltd. 112

F

Ferranti, Ltd. 26
Fielden Electronics, Ltd. 162
Flann Microwave Instruments, Ltd. 181
Fortiphone, Ltd. 187
Fox, P. X., Ltd. 55
Fulham Electrical Components, Ltd. 122

G

Gardner, Henry, Ltd. 124
General Electric Co., Ltd. 95, 117, 166
Goodmans Industries, Ltd. 61
Gresham Developments, Ltd. 128
Gresham Transformers, Ltd. 103
Guyson Industrial Equipment, Ltd. 169

H

Haddon Transformers, Ltd. 114
Harboro' Rubber Co., Ltd. 188
Harwin Engineers, Ltd. 43
Hassett & Harper, Ltd. 49
Henry & Thomas, Ltd. 143
Hilton Electric Co., Ltd. 169
Hinchley Engineering, Ltd. 76
Hirst Electronic, Ltd. 181
Hivac, Ltd. 165
Hunting Engineering, Ltd. 196, 199

I

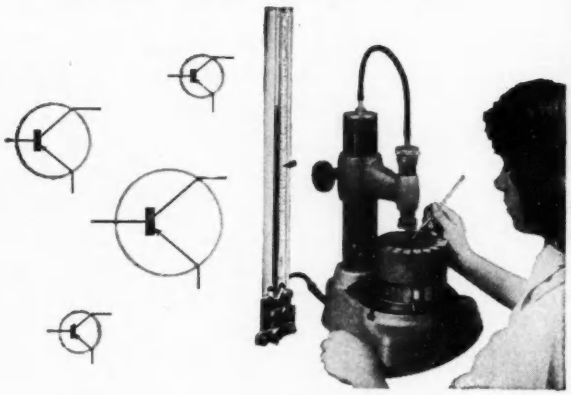
Ilford, Ltd. 54
Imhof, Alfred, Ltd. 56
Industrial & Trade Fairs, Ltd. 19
Insuloid Mfg. Co., Ltd. 157, 172
Ioco, Ltd. 154

J

Jackson Brothers (London), Ltd. 160
Jason Motor & Electronic Co., Ltd. 152
Johnson Matthey & Co., Ltd. 105
Jones & Rooke (1948), Ltd. 33

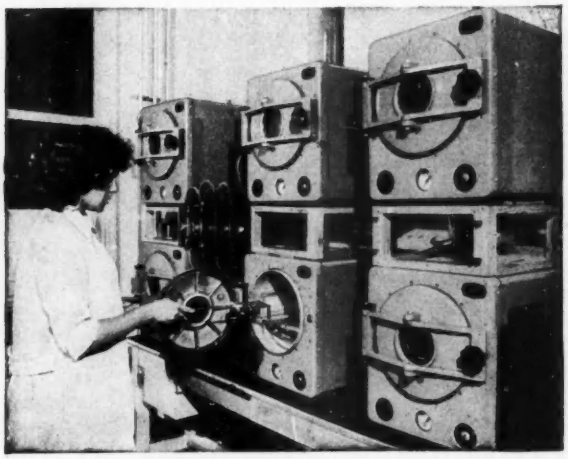
(*Continued on next page*)

creating the right atmosphere



transistor manufacture

In the manufacture of transistors, Siemens Edison Swan Limited use a Birlec direct dehumidifier to maintain dry, dust-free conditions for the preparation and final assembly of germanium wafers. Maintaining 10% relative humidity conditions, the direct dehumidifier ensures accurate grading of the wafers according to thickness, and perfect electrical contact between the wafers forming emitter, base, and collector in the transistor.



Above : Drying germanium wafers in vacuum ovens
Left : Grading germanium wafers prior to assembling into transistors

DRYER DIVISION OF

BIRLEC LIMITED

AN A.E.I. COMPANY

ERDINGTON · BIRMINGHAM · 24

BIRLEC DIRECT DEHUMIDIFIERS FOR AIR-CONDITIONING

LONDON · SHEFFIELD · GLASGOW
NEWCASTLE-ON-TYNE · JOHANNESBURG

EE 8270 *for further details*

INDEX TO ADVERTISERS *(continued from previous page)*

K

K.C. Clips, Ltd. 160
Kasma Electronics, Ltd. 158
Kempes Engineer's Year Book 188
Kent, George, Ltd. 60
Ketay, Ltd. 144

L

Langham Thompson, J., Ltd. 9
Light, H. A. (Productions), Ltd. 160
Lightwood & Son, Ltd. 148
Lintronic, Ltd. 168
Livingston Laboratories, Ltd. 8
London Electric Wire Co. & Smiths Ltd. & Vactite Wire Co., Ltd. 153
London Electrical Mfg. Co., Ltd. 123
Low Moor Alloy Steelworks, Ltd. 139
Lyons, Claude, Ltd. 13

M

M.O. Valve Co., Ltd., ... 95
Magnetic Devices, Ltd. 94
Marconi's Wireless Telegraph Co., Ltd. 25, 201
Marshalls' Flying School, Ltd. 198
Measuring Instruments (Pullin), Ltd. 145
Mervyn Instruments 191
Metal Box Co., Ltd. (The) 198
Metropolitan Plastics, Ltd. 23
Micro-Electric, Ltd. 201
Midland Silicones, Ltd. 27
Miltoid Sales Division (B X Plastics, Ltd.) .. 181
Modern Acoustics, Ltd. 131
Muirhead & Co., Ltd. 182
Mullard, Ltd. 20, 38, 39, 104, 133
Multicore Solders, Ltd. 137

N

N.G.N. Electrical, Ltd. 187
Nagard, Ltd. 62
Nash & Thompson, Ltd. 79
Neill, James, & Co. (Sheffield), Ltd. 159
Neoflex, Ltd. 174
Newmarket Transistor Co., Ltd. 14, 15
Newport Instruments (Scientific & Mobile), Ltd. 173
Newton Bros. (Derby), Ltd. 156
Nuclear Enterprises (G.B.), Ltd. 177

O

Overell & Co., Ltd. 166
Oxford University 200
Oxley Developments Co., Ltd. 174

P

P. & H. Engineering Co., Ltd. 153
Painton & Co., Ltd. .. .. .. Front Cover
Panorama Radio Co. 166
Parmeko, Ltd. 121
Partridge Transformers, Ltd. 183
Permali, Ltd. 184
Phillips Control (Gt. Britain), Ltd. 176
Plannair, Ltd. 125
Plessey Co., Ltd. 18, 90, 120, 197
Polarad Electronics Corporation 41
Polypenco, Ltd. 163
Portsmouth Aviation, Ltd. 187
Powis, David, & Sons, Ltd. 180
Pressphan, Ltd. 188
Pullin, R. B., & Co., Ltd. 92, 93
Pye, Ltd. 200
Pye Telecommunications, Ltd. 201
Pye, W. G., & Co., Ltd. 10

Q

Quartz Crystal Co., Ltd. 160

R

Racal Engineering, Ltd. 2, 197
Radiometer 157
Radiospares, Ltd. 127
Rainbow Radio Mfg. Co., Ltd. 174
Rank Cintel, Ltd. 132
Reliance Mfg. Co., Ltd. 174
Research & Control Instruments, Ltd. .. 178
Rivlin Instruments, Ltd. 21
Roband Electronics, Ltd. 4, 5, 115
Rocol, Ltd. 78
Rollet, H., & Co., Ltd. 63
Royal Worcester Industrial Ceramics, Ltd. .. 179

S

Salter, George, & Co., Ltd. 6
Sangamo Western, Ltd. 150
Savage Transformers, Ltd. 149
Saxonia Electrical Wire Co., Ltd. 201
Scott, James, & Co. (Electrical Engineers) Ltd. 150
Semiconductors, Ltd. 42
Servo & Electronic Sales, Ltd. 176
Servomex Controls, Ltd. 46, 47
Shardlow Micrometers, Ltd. 178
Siemens Edison Swan, Ltd. 24, 193
Sierex, Ltd. 72
Silentbloc, Ltd. 36
Sketchley, Ltd. 12
Solartron Electronic Group, Ltd. 81, 108, 110, 195, 196
South London Electrical Equipment Co., Ltd. 145
Spear Engineering Co., Ltd. 180
Spencer & Sons (Market Harborough), Ltd. .. 171
Sperry Gyroscope Co., Ltd. 155
Spring Steel Productions, Ltd. 146
Standard Telephones & Cables, Ltd. 83, 85, 87, 89, 91
Steatite & Porcelain Products, Ltd. 73
Stewart Transformers, Ltd. 179
Stonebridge Electrical Co., Ltd. 146
Suflex, Ltd. 185
Super Electronics, Ltd. 180
Surrey Steel Components, Ltd. 162

T

Taylor Electrical Instruments, Ltd. 171
Techna (Sales), Ltd. 144
Techograph Electronic Products, Ltd. .. 16
Telecommunication Instruments, Ltd. .. 182
Telephone Mfg. Co., Ltd. 53
Terry, Herbert, & Sons, Ltd. 64
Texas Instruments, Ltd. Inset facing pp. 80 & 81
Thermal Syndicate, Ltd. 170
Thorn Electrical Industries, Ltd. 116
Trist, Ronald, & Co., Ltd. 180
Trumeter Co., Ltd. 183

U

U.K.A.E.A. 194, 200
Ultra Electric, Ltd. 199

V

Vactric (Control Equipment), Ltd. 151
Vacwell Engineering Co., Ltd. 172
Vandyke Engineering, Ltd. 168
Venner Electronics, Ltd. 57
Venus Pencil Co., Ltd. 142

W

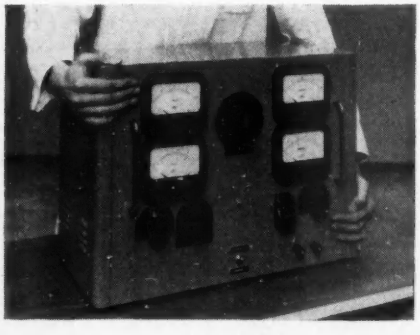
Webber, R. A., Ltd. 180
Welwyn Tool Co., Ltd. 142
Westool, Ltd. 50, 51
Whiteley Electrical Radio Co., Ltd. 191
Wilkinson, L. (Croydon), Ltd. 160
Winston Electronics, Ltd. 75
Woden Transformer Co., Ltd. 161
Woods of Colchester, Ltd. 164

Z

Zenith Electric Co., Ltd. 161

The Jobs we do...

and like doing!



One section of our factory and staff, headed by a young but experienced director, provides a pre-production service of such reliability that it can be regarded as an extension of your own resources. This group can take a batch of development drawings, prove them, compile parts lists, and carry out either "one-off" prototypes or short pilot runs. The picture here is typical—a piece of specialized test gear for the laboratory testing of transistors—which we recently produced for the research unit of an important Anglo-American group of radio and television companies. Guaranteed delivery is a cardinal feature of our pre-production service; we will not undertake a job unless we can be sure of completing it by the required date. And our charges are not at all excessive.

BROXLEA PRODUCTS LIMITED

A.I.D.—approved sub-contractors

PARK LANE,
BROXBOURNE,
HERTFORDSHIRE

'Phone : Hoddesdon 4455

EE 8271 *for further details*

Printed in Great Britain by The Press at Coombelands, Ltd., Addlestone, Surrey, for the Proprietors, Morgan Brothers (Publishers), Ltd., 28, Essex Street Strand, W.C.2.
Registered for Transmission by Canadian Magazine Post.

208/64

EE 8273 *for further details*

Living Together

Pluggable Components

R E S I S T O R
L I M I T E D

200°F

500°F

1000°F

2000°F

HEAT RESISTANT...

At aircraft firewalls or in guided missiles . . . wherever high temperatures are encountered . . . you can get full protection by using Cannon Steel Shell High Temperature Connectors to protect electrical circuits.

MS 3108 K TYPE

MS 3100 K TYPE

MS 3106 K PLUG

Cannon Electric supplies both MS-K and FW fireproof types of electrical connectors for the protection of vital circuits in flame barrier applications.

The fireproof test of Military Specification MIL-C-5015 assures that a connector will carry a specified current for 5 minutes and prevent the passage of flame for twenty minutes while being subjected to a flame of 2000°F. Cannon AN-K Connectors meet this specification.

In addition to firewall plugs Cannon Electric has developed connectors that operate continuously up to 1000°F. Developments are under way that will increase the temperature range. We would like to suggest that you will find it well worth your while to consult our engineering personnel for full information on the newest high temperature connectors available.

For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

CANNON PLUGS

WHERE RELIABILITY IS THE 5th DIMENSION

AWARENESS OF PROBLEM — EFFICIENCY OF EFFORT — DESIGN EFFORT — MANUFACTURING CONTROL

2833

CANNON ELECTRIC (Great Britain) **LTD.**

138 Wardour Street, London, W.1. *Tel: GER 7711-9 Cable: Cannonelec London, Telex: 23521*

Factories in London, Los Angeles, Salem, Toronto, Melbourne. Licensees in Paris and Tokio